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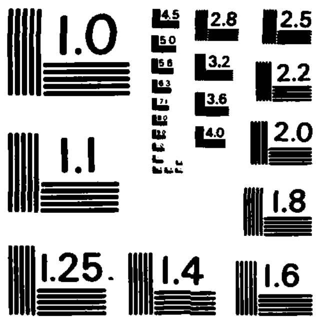

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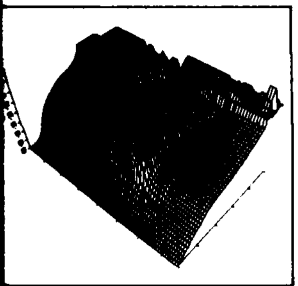

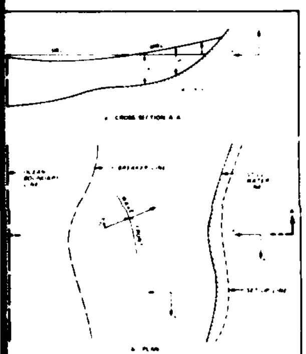

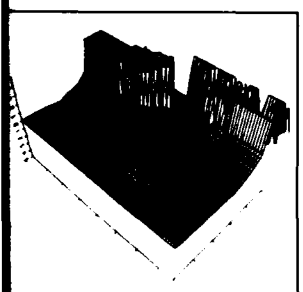

HYDRAULICS LABORATORY

AD-A148 102

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TECHNICAL REPORT HL-80-3

EROSION CONTROL OF SCOUR DURING CONSTRUCTION

Report 7

CURRENT — A WAVE-INDUCED CURRENT MODEL

by

S. Rao Vemulakonda

Coastal Engineering Research Center

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Often, large-scale engineering structures such as jetties or breakwaters are constructed in the nearshore region to stabilize navigation channels or protect harbor entrances and beaches. During construction, these structures may alter waves and currents. Waves break on such structures and the resulting turbulence causes material to be tossed into suspension and be transported from the region by wave-induced and other currents. This results in erosion at the toe of the structure since natural influx of material may not exist to one,

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20. ABSTRACT (Continued).

replace that removed from the region. In order to ensure structural stability, it is necessary to fill this area with nonerodible material. As a result, extra quantities of material may be required, and construction costs may be overrun. To minimize cost increases due to scour during construction, it is necessary to estimate the likelihood and amount of potential scour during construction. Since breaking waves and the currents induced by them play a vital role in transporting sediment away from coastal structures, thus resulting in scour, it is important to predict wave-induced currents, with and without structures.

The purpose of this study is to develop a generalized numerical model that will predict currents induced by breaking waves at locations with or without coastal structures. The model should be applicable to real-life bathymetries that are often arbitrary and irregular and must be computationally efficient and economical in view of the large numerical grids often required in engineering projects.

The numerical model called CURRENT developed in this study employs the radiation stress approach of Longuet-Higgins and solves the vertically integrated equations of momentum and continuity using an alternating direction implicit scheme. It includes mixing and advection terms.

The model has been applied to a case of normally incident waves on a plane beach. Results for setup matched the experimental data of Bowen, Inman, and Simmons. For obliquely incident waves on a plane beach, model results for longshore currents were compared with the analytical solution of Longuet-Higgins, first neglecting the effect of setup and later including the effect of setup. Agreement was excellent. As the numerical grid was made finer, the numerical results tended to converge toward the analytical solution.

The numerical model was applied to a field situation corresponding to Oregon Inlet, North Carolina. The bathymetry was very irregular and complex owing to the presence of channels, shoals, etc. A variable grid was used, and the significant wave during a part of the Ash Wednesday storm of March 1962 was simulated. The numerical results obtained for this case appeared to be reasonable, and the computer costs were modest.

For user convenience, model input, output, and files are described and two sample applications are presented.

PREFACE

The study reported herein was authorized as a part of the Civil Works Research and Development Program by the Office, Chief of Engineers (OCE), US Army. This particular work unit, Erosion Control of Scour During Construction, is part of the Improvement of Operations and Maintenance Techniques (IOMT) Program. Mr. James L. Gottesman was the OCE Technical Monitor for the IOMT Program during preparation and publication of this report.

This study was conducted during the period 1 January 1981 through 31 March 1982 by personnel of the Hydraulics Laboratory of the US Army Engineer Waterways Experiment Station (WES) under the general supervision of Messrs. H. B. Simmons, Chief of the Hydraulics Laboratory; F. A. Herrmann, Jr., Assistant Chief of the Hydraulics Laboratory; R. A. Sager, Chief of the Estuaries Division and IOMT Program Manager; Dr. R. W. Whalin and Mr. C. E. Chatham, former and acting Chiefs of the Wave Dynamics Division, respectively; Mr. D. D. Davidson, Chief of the Wave Research Branch; and Dr. J. R. Houston, Research Hydraulic Engineer and Principal Investigator for the Erosion Control of Scour During Construction work unit. The Wave Dynamics Division was transferred to the Coastal Engineering Research Center (CERC) of WES on 1 July 1983 under the direction of Dr. R. W. Whalin, Chief of the Coastal Engineering Research Center. This report was prepared by Dr. S. Rao Vemulakonda, Research Hydraulic Engineer.

Commanders and Directors of WES during the conduct of this investigation and the preparation and publication of this report were COL Nelson P. Conover, CE, and COL Tilford C. Creel, CE. Technical Director was Mr. F. R. Brown.

CONTENTS

CONVERSION FACTORS, US CUSTOMARY TO METRIC (SI) UNITS OF MEASUREMENT

US customary units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	By	To Obtain
feet	0.3048	metres
feet per second	0.3048	metres per second
feet-feet per second	0.0929	metres-metres per second
feet per second per second	0.3048	metres per second per second
pounds (mass) per square foot	4.882428	kilograms per square metre
pounds per foot	1.488189	kilograms per metre
pounds-second-second per foot per foot per foot per foot	52.5540137	kilogram-second-second per metre per metre per metre per metre

EROSION CONTROL OF SCOUR DURING CONSTRUCTION

CURRENT--A WAVE-INDUCED CURRENT MODEL

PART I: INTRODUCTION

Statement of the Problem

1. Often, large-scale engineering structures such as jetties and breakwaters are constructed in the nearshore region to stabilize navigation channels or protect harbor entrances and beaches. The structures are usually built of rock or precast concrete. During construction, the massive structures alter the waves and currents near their location. Waves break on the toe of the structure and the resulting turbulence causes material from the bottom to be suspended. The suspended material in turn is moved away from the region by wave-induced and other currents. This results in erosion developing at the toe of the structure since the lost material may not be replaced by natural processes. In order to ensure that the structure will be stable and perform its function as desired, it will be necessary to fill with nonerodible material any scour hole that may have developed due to erosion. As a result, extra quantities of material may be required and construction costs may be overrun. To minimize cost increases due to scour during construction, it is necessary to estimate beforehand the likelihood and amount of potential scour during construction. This is a very complicated problem and the solution to it will depend strongly on the particular field site and the coastal environment.

2. Since breaking waves and the currents induced by them play a vital role in transporting sediment away from coastal structures resulting in scour, it is important to predict wave-induced currents, with and without structures. In view of the environment and site-specific nature of the problem, a generalized numerical model is needed. Results from such a model can be used as input to a sediment transport model to predict erosion during construction.

Purpose of the Study

3. The purpose of this study is to develop a generalized numerical model

that can predict currents induced by breaking waves at locations with or without coastal structures. The model should be applicable to real-life bathymetries that are often arbitrary and irregular and should be computationally efficient and economical in view of the large numerical grids often required in engineering projects.

PART II: THEORETICAL BACKGROUND

Review

4. In recent years, there has been a growing interest in the numerical modeling of longshore currents and nearshore circulation caused by the action of breaking waves. Results of such simulation, besides being useful on their own, form an essential input to numerical and physical models for nearshore processes such as sediment transport. The design and construction of large-scale engineering structures such as jetties require the determination of wave-induced currents not only near the open coast but also near inlets; in addition, the effects of the proposed or existing structures on these currents are required. Several publications on longshore currents and nearshore circulation have appeared in the literature during the past two decades. Some of these relate to experimental or field studies and others to analytic solutions and numerical models. Among the latter, mention must be made of Bowen (1969), Longuet-Higgins (1970), Thornton (1970), Noda (1974), Jonsson, Skovgaard, and Jacobsen (1974), Birkemeier and Dalrymple (1975), Liu and Mei (1976), Liu and Lennon (1978), Liu and Dalrymple (1978), Ebersole and Dalrymple (1980), and Vreugdenhil (1980). Several of these studies and models either consider only simple and idealized situations, for example, plane beaches and periodic bathymetries, or neglect terms of the governing equations involving unsteadiness, advection, and/or lateral mixing. Often, a linear friction is assumed. For practical engineering application, a generalized numerical model is needed that can handle real-life bathymetries. The model should be flexible in that one should be able to change easily the formulation of terms such as mixing and friction as improved understanding of these processes is gained in the future. It should be computationally efficient and economical for large numerical grids. This report describes one such numerical model for wave-induced currents developed at the US Army Engineer Waterways Experiment Station (WES). The model called "CURRENT" has been applied successfully to the determination of longshore currents near open coasts and wave-induced currents near inlets. It can handle impermeable nonovertopping structures.

5. In terms of its analytic formulation the present model uses, to a large extent, the approach of Ebersole (1980), and Ebersole and Dalrymple (1980). Whereas their numerical model used an explicit method of solution,

the present model uses a highly efficient alternating direction, implicit, finite difference scheme. In view of the similarity between the equations for wave-induced currents and long waves, the present model was created by modifying an existing, well-tested WES shallow-water wave numerical model known as WIFM (WES Implicit Flooding Model) (Butler 1980). The velocity version of WIFM used here has nonlinear advective terms. The friction and mixing terms used in WIFM were modified to conform to the formulations normally used for wave-induced currents. Radiation stress terms were added to the model, since these are usually the "driving" terms for wave-induced currents. Certain capabilities of WIFM such as flooding/drying and wind-induced current calculation were not utilized in the model for wave-induced currents.

Equations of Motion

6. The hydrodynamic equations used in the model for wave-induced currents may be derived from the Navier-Stokes equations (for details, see Phillips (1969) and Ebersole (1980)). It is assumed in the derivation that the fluid is homogeneous and incompressible, and the vertical accelerations are negligible so that the pressure distribution is hydrostatic. By vertically integrating the three-dimensional form of the equations and applying appropriate boundary conditions, the depth-averaged two-dimensional form of the equations of motion and continuity are obtained. These equations are derived by time-averaging over a time interval corresponding to the period of the waves. Refe..ing to a Cartesian coordinate scheme (Figure 1), these are:

Momentum

$$\frac{\partial U}{\partial t} + U \frac{\partial U}{\partial x} + V \frac{\partial U}{\partial y} + g \frac{\partial \bar{\eta}}{\partial x} + \frac{1}{\rho d} \tau_{bx} + \frac{1}{\rho d} \left(\frac{\partial S_{xx}}{\partial x} + \frac{\partial S_{xy}}{\partial y} \right) - \frac{1}{\rho} \frac{\partial \tau_{xy}}{\partial y} = 0 \qquad (1)$$

$$\frac{\partial V}{\partial t} + U \frac{\partial V}{\partial x} + V \frac{\partial V}{\partial y} + g \frac{\partial \bar{\eta}}{\partial y} + \frac{1}{\rho d} \tau_{by} + \frac{1}{\rho d} \left(\frac{\partial S_{xy}}{\partial x} + \frac{\partial S_{yy}}{\partial y} \right) - \frac{1}{\rho} \frac{\partial \tau_{xy}}{\partial x} = 0 \qquad (2)$$

Continuity

$$\frac{\partial \bar{\eta}}{\partial t} + \frac{\partial}{\partial x} (Ud) + \frac{\partial}{\partial y} (Vd) = 0 \qquad (3)$$

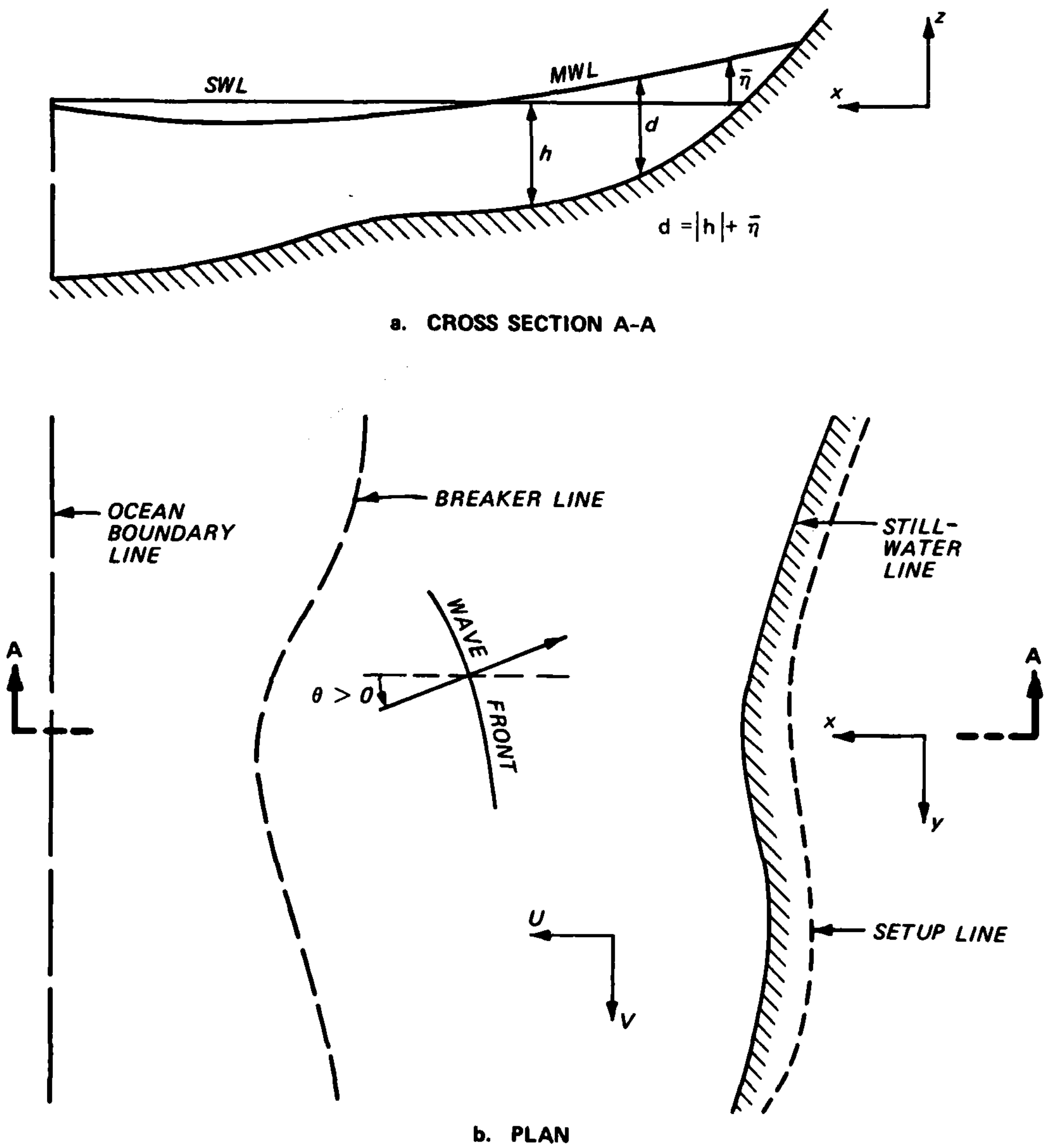

Figure 1. Definition sketch for an irregular beach

where

U and V = depth-averaged horizontal velocity components at time t in the x- and y-directions, respectively, ft/sec*

$\bar{\eta}$ = displacement of the mean free surface with respect to the still-water level, ft

g = acceleration due to gravity, ft/sec^2

ρ = mass density of seawater, lb-sec^2/ft^4

$d = \bar{\eta} - h$ = total water depth, ft

h = bed elevation with still-water level taken as zero (note h is negative for water cells and positive for land cells), ft

τ_{bx} and τ_{by} = bottom friction stresses in the x- and y-directions, respectively, lb/ft^2

S_{xx}, S_{xy}, and S_{yy} = radiation stresses which arise because of the excess momentum flux due to waves (refer to Longuet-Higgins and Stewart (1964) for their significance), lb/ft

τ_{xy} = lateral shear stress due to turbulent mixing, lb/ft^2

Note that the condition $\bar{\eta} > 0$ is known as "setup" and $\bar{\eta} < 0$ is called "setdown."

Bottom friction

7. At present, the numerical model uses a linear formulation for friction (Longuet-Higgins 1970). Thus

$$\tau_{bx} = \rho c \langle |u_{orb}| \rangle U \tag{4}$$

$$\tau_{by} = \rho c \langle |u_{orb}| \rangle V \tag{5}$$

where c is a drag coefficient (of the order of 0.01) and $\langle |u_{orb}| \rangle$ is the time average, over one wave period, of the absolute value of the wave orbital velocity at the bottom. From linear wave theory,

$$\langle |u_{orb}| \rangle = \frac{2H}{T \sinh k|h|} \tag{6}$$

---

* A table of factors for converting US customary units of measurement to metric (SI) units is presented on page 3.

where

H = local wave height, ft

T = wave period, sec

k = local wave number, $2\pi/L$, 1/ft

$|h|$ = local still-water depth, ft

Equations 4 and 5 are based on the assumption that the velocity components U and V of the current are small compared with the wave orbital velocity, $\langle|u_{orb}|\rangle$. In the future, the numerical model can be easily adapted to other formulations for friction such as nonlinear friction.

Radiation stresses

8. As mentioned previously, the radiation stresses are of major importance since they furnish the main forces for creating wave-induced currents. Referring to Longuet-Higgins (1970), for monochromatic waves, they are defined in terms of the local wave climate as follows:

$$S_{xx} = E\left[\left(2n - \frac{1}{2}\right)\cos^2\theta + \left(n - \frac{1}{2}\right)\sin^2\theta\right] \tag{7}$$

$$S_{xy} = E\,n\cos\theta\sin\theta \tag{8}$$

$$S_{yy} = E\left[\left(2n - \frac{1}{2}\right)\sin^2\theta + \left(n - \frac{1}{2}\right)\cos^2\theta\right] \tag{9}$$

where

$$E = \frac{1}{8}\rho g H^2 \tag{10}$$

and

$$n = \frac{1}{2}\left(1 + \frac{2k|h|}{\sinh 2k|h|}\right) \tag{11}$$

Note that n is the ratio of wave group celerity to phase celerity, θ is the local wave direction defined as shown in Figure 1, and E is the wave energy density, lb/ft. For the numerical model described herein, the values of H , k , and θ are obtained by using a considerably modified form of the wave climate program developed by Noda et al. (1974). This particular program has the advantage that H , k , and θ can be computed at the centers of the cells of a rectangular numerical grid and wave breaking and decay are accounted for by a breaking index model for wave heights in the surf zone.

Lateral shear

9. In the numerical model, the coordinate scheme is chosen such that x is positive in the offshore direction and y is approximately in the alongshore direction. An eddy viscosity formulation is chosen for the lateral shear. The eddy viscosity is assumed to be anisotropic. Denoting ε_x and ε_y as the eddy viscosities in x- and y-directions, respectively, in general, ε_x is assumed to be a function of x and y and ε_y a constant. Accordingly,

$$\tau_{xy} = \rho\left(\varepsilon_y \frac{\partial U}{\partial y} + \varepsilon_x \frac{\partial V}{\partial x}\right) \tag{12}$$

For plane beach applications with lateral mixing, the eddy viscosity ε_x was assumed to vary within the surf zone in the manner suggested by Longuet-Higgins (1970):

$$\varepsilon_x = N_{LH} x \sqrt{g|h|} \tag{13}$$

where

N_{LH} = an empirical coefficient that varies in the range 0.0 to 0.016

x = distance from the shoreline

For locations offshore of the breaker line, ε_x was kept constant and equal to its value at the breaker line. For field applications, the eddy viscosity ε_x was chosen according to the following relation given by Jonsson, Skovgaard, and Jacobsen (1974):

$$\varepsilon_x = \frac{H^2 gT}{4\pi^2 |h|} \cos^2 \theta \tag{14}$$

This represents twice the value used by Thornton (1970). It was believed that for field situations, Equation 14 represented the eddy viscosities more realistically than the relation (Equation 13) for plane beaches. The value of ε_y was, in general, taken to be equal to the value of ε_x at the deepest part (usually near the offshore boundary) of the numerical grid. The numerical model is flexible enough to permit other formulations for eddy viscosity in the future, as our understanding improves.

Variable grid

10. One major advantage of WIFM and therefore CURRENT is that the size of the grid cells may be varied smoothly in both horizontal directions. Thus

the grid may be made finer in regions of greater interest such as the surf zone, inlets, etc., and coarser in regions of less importance. For this purpose, a piecewise reversible transformation is used. The mapping for each coordinate direction is independent of the other. For mapping from the real or physical space (x, y) to the computational space (α_1, α_2), a mapping function of the form

$$x = a_1 + b_1 \alpha_1^{c_1} \tag{15}$$

is used. A similar mapping function is employed for the y-direction. Here a_1, b_1, and c_1 are coefficients whose values change from region to region. The mapping transforms the variable grid in real space to a uniform grid in computational space. The transformation is such that all derivatives are centered in α-space. During the mapping process, both the variable and its derivative must match at the common boundary between two regions. The mapping is actually accomplished by an iterative procedure, using an interactive program called MAPIT developed at WES. Figure 2 shows an example of the variable grid.

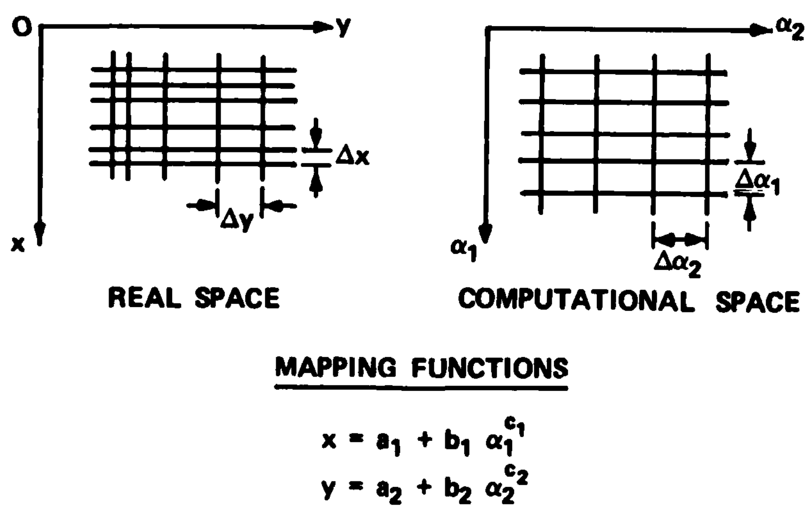

Figure 2. An example of variable grid

11. By using the mapping function in the x- and y-directions, the equations of motion in computational space may be written as:

Momentum

$$U_t + \frac{1}{\mu_1} UU_{\alpha_1} + \frac{1}{\mu_2} VU_{\alpha_2} + \frac{g}{\mu_1} \bar{\eta}_{\alpha_1} + \frac{1}{\rho d} \tau_{bx} + \frac{1}{\rho d}\left[\frac{1}{\mu_1}\left(S_{xx}\right)_{\alpha_1} + \frac{1}{\mu_2}\left(S_{xy}\right)_{\alpha_2}\right]$$

$$- \varepsilon_x \frac{1}{\mu_2}\frac{1}{\mu_1} V_{\alpha_2\alpha_1} - \varepsilon_y \frac{1}{\mu_2}\left[\frac{1}{\mu_2} U_{\alpha_2\alpha_2} + \left(\frac{1}{\mu_2}\right)_{\alpha_2} U_{\alpha_2}\right] - \frac{1}{\mu_1\mu_2}\left(\varepsilon_x\right)_{\alpha_2} V_{\alpha_1} = 0 \qquad (16)$$

$$V_t + \frac{1}{\mu_1} UV_{\alpha_1} + \frac{1}{\mu_2} VV_{\alpha_2} + \frac{g}{\mu_2} \bar{\eta}_{\alpha_2} + \frac{1}{\rho d} \tau_{by} + \frac{1}{\rho d}\left[\frac{1}{\mu_1}\left(S_{xy}\right)_{\alpha_1} + \frac{1}{\mu_2}\left(S_{yy}\right)_{\alpha_2}\right]$$

$$- \varepsilon_x \frac{1}{\mu_1}\left[\frac{1}{\mu_1} V_{\alpha_1\alpha_1} + \left(\frac{1}{\mu_1}\right)_{\alpha_1} V_{\alpha_1}\right] - \varepsilon_y \frac{1}{\mu_1}\frac{1}{\mu_2} U_{\alpha_1\alpha_2} - \frac{1}{\mu_1^2}\left(\varepsilon_x\right)_{\alpha_1} V_{\alpha_1} = 0 \qquad (17)$$

Continuity

$$\bar{\eta}_t + \frac{1}{\mu_1}\left(Ud\right)_{\alpha_1} + \frac{1}{\mu_2}\left(Vd\right)_{\alpha_2} = 0 \qquad (18)$$

where the subscripts t , α_1 , and α_2 indicate partial derivatives with respect to time, α_1 and α_2 , respectively, and

$$\mu_1 = \frac{\partial x}{\partial \alpha_1} = b_1 c_1 \alpha_1^{c_1 - 1} \qquad (19)$$

and

$$\mu_2 = \frac{\partial y}{\partial \alpha_2} = b_2 c_2 \alpha_2^{c_2 - 1} \qquad (20)$$

Variables μ_1 and μ_2 are expansion coefficients connected with the stretching of the uniform computational grid to the variable grid in real space. Note that in obtaining Equations 16 and 17, the assumptions made in paragraph 9 were used.

12. The nonlinear advective terms in the equations of motion often pose stability problems. These terms are handled in the present model by using the Stabilizing Correction (SC) scheme. This scheme will be described in a later

section. The eddy viscosity terms also can cause difficulties during the numerical computation. The finite difference scheme selected and the formulation for eddy viscosity adopted in the model will minimize such difficulties and stability problems. However, the user must exercise caution and judgment in selecting appropriate time- and space-steps, and eddy viscosity coefficients for the phenomena being simulated.

PART III: COMPUTATIONAL TECHNIQUES

Implicit Method

13. In order to solve the problem under consideration on a digital computer, the differential equations (Equations 16-18) have to be expressed in a finite difference form. In the present case, an alternating direction, implicit, finite difference scheme is employed. In view of the presence of the nonlinear advective terms, a particular implicit scheme known as the SC scheme is used. The basic idea of the scheme is as follows. The time level is indicated by a superscript k . The scheme involves variables at three time levels. The values of the variable at time levels $k-1$ and k are known from previous computations or prescribed initial conditions. To advance the solution from time level k to the new time level $k+1$, we introduce an intermediate time-level solution denoted by the superscript $*$. We operate on Equations 16-18 in a two-step procedure. In the first step, we sweep the rectangular grid in the $x(\alpha_1)$ direction, advancing the solution from time level k to $*$. Next, we sweep the grid in the $y(\alpha_2)$ direction, advancing the solution from time level $*$ to $k+1$. The two sweeps together constitute a full time-step, Δt .

Double-Sweep Technique

14. Before going into the details of the double sweep technique, the notation used for individual cells of the rectangular grid will be defined. Let Δx and Δy denote the cell dimensions in real space in the x- and y-directions, respectively. These dimensions may vary from cell to cell. Let the corresponding dimensions in computational space be $\Delta\alpha_1$ and $\Delta\alpha_2$. These dimensions are the same for all the cells in the grid. Let m and n denote indices corresponding to the center of an arbitrary cell (Figure 3). All the variables

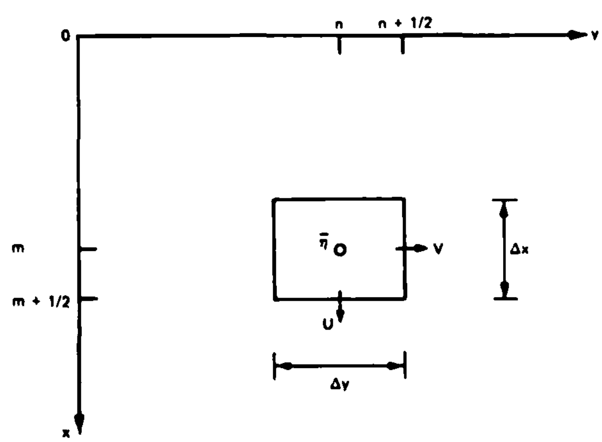

Figure 3. Cell notation

except the velocities $\bar{U}$ and $\bar{V}$ are defined at the cell centers. Velocities U and V are defined at cell faces m+1/2 and n+1/2, respectively. In the x-sweep, the x-momentum equation is centered about the cell face m+1/2 and the continuity equation is centered about the center of the cell and the two equations are solved, using in the process the result $U^* = U^{k+1}$. At the end of this sweep, $\bar{\eta}^*$ and U^{k+1} are known. Next, we sweep the grid in the y-direction. In this sweep, the y-momentum equation is centered about the cell face n+1/2 and the continuity equation about the cell center. Upon solving the two equations, $\bar{\eta}^{k+1}$ and V^{k+1} for each cell are obtained. Thus the two sweeps together complete the solution for $\bar{\eta}^{k+1}$, U^{k+1}, and V^{k+1}.

15. Even though the SC scheme has been described so far in terms of the (x, y) coordinate system for convenience, in reality we have to apply the technique to the equations of motion in the computational (α_1, α_2) space. After the application of the technique, the following finite difference equations result. For the rest of PART III, we will drop the bar over η for convenience. For the α_1(x)-sweep (taken along a grid cell column parallel to the α_1-axis), we have

$$\frac{1}{2\Delta t}\left(U^{k+1} - U^{k-1}\right) + \frac{U^k}{2\mu_1\Delta\alpha_1}\,\delta_{2\alpha_1}\left(U^k\right) + \frac{\bar{\bar{V}}^k}{2\mu_2\Delta\alpha_2}\,\delta_{2\alpha_2}\left(U^k\right)$$

$$+ \frac{g}{2\mu_1\Delta\alpha_1}\,\delta\alpha_1\left(\eta^* + \eta^{k-1}\right) + \frac{c<\left|\overline{u_{orb}}\right|^k>U^{k+1}}{\bar{d}} + \frac{1}{\rho\bar{d}}\left[\frac{1}{\mu_1\Delta\alpha_1}\,\delta_{\alpha_1}\left(S_{xx}^k\right)\right.$$

$$\left. + \frac{1}{2\mu_2\Delta\alpha_2}\,\delta_{2\alpha_2}\left(\bar{\bar{S}}_{xy}^k\right)\right] - \bar{\varepsilon}_x\,\frac{1}{\mu_2}\,\frac{1}{\mu_1}\,\frac{1}{\Delta\alpha_2\Delta\alpha_1}\,\delta_{\alpha_2\alpha_1}\left(V^k\right) - \bar{\varepsilon}_y\left[\frac{1}{\left(\mu_2\Delta\alpha_2\right)^2}\,\delta_{\alpha_2\alpha_2}\left(U^k\right)\right. \tag{21}$$

$$\left. + \frac{1}{2\mu_2\left(\Delta\alpha_2\right)^2}\,\delta_{\alpha_2}\left(\frac{1}{\mu_2}\right)\delta_{2\alpha_2}\left(U^k\right)\right] - \frac{1}{2\mu_1\mu_2}\,\frac{1}{\Delta a_2\Delta\alpha_1}\,\delta_{2\alpha_2}\left(\bar{\varepsilon}_x\right)\delta_{\alpha_1}\left(\bar{\bar{V}}^k\right) = 0$$

at (n, m+1/2)

$$\frac{1}{2\Delta t}\left(\eta^* - \eta^{k-1}\right) + \frac{1}{2\mu_1\Delta\alpha_1}\,\delta_{\alpha_1}\left(U^{k+1}\,\bar{d}^k + U^{k-1}\,\bar{d}^k\right)$$

$$+ \frac{1}{\mu_2\Delta\alpha_2}\,\delta_{\alpha_2}\left(V^{k-1}\,\bar{d}^k\right) = 0 \quad \text{at} \quad (n,m) \tag{22}$$

In the above equations, a single bar represents a two-point average and a double bar a four-point average. The difference operator δ_{α_i} is defined as

$$\delta_{\alpha_i}(Z) = Z_{\alpha_{i+1/2}} - Z_{\alpha_{i-1/2}} \tag{23}$$

for any variable Z . The definition may be extended to the operators $\delta_{2\alpha_i}$ and $\delta_{\alpha_i \alpha_j}$.

16. Equations 21 and 22 may be rearranged so that the unknown quantities are to the left and the known quantities are to the right, as follows:

$$-a_m \eta^*_{n,m} + \bar{a}_{m+1/2} U^{k+1}_{n,m+1/2} + a_{m+1} \eta^*_{n,m+1} = B_{m+1/2} \tag{24}$$

$$-a_{m-1/2} U^{k+1}_{n,m-1/2} + \eta^*_{n,m} + a_{m+1/2} U^{k+1}_{n,m+1/2} = A_m \tag{25}$$

where

$$a_m = a_{m+1} = \frac{g\Delta t}{(\mu_1)_{m+1/2} \Delta\alpha_1} \tag{26}$$

$$\bar{a}_{m+1/2} = 1 + \frac{2\Delta t c < \overline{|u_{orb}|}^k >_{n,m+1/2}}{\bar{d}^k_{n,m+1/2}} \tag{27}$$

$$\begin{aligned} B_{m+1/2} = U^{k-1} + \Delta t \Bigg\{ & - \frac{U^k}{\mu_1 \Delta\alpha_1} \delta_{2\alpha_1}(U^k) - \frac{\bar{\bar{V}}^k}{\mu_2 \Delta\alpha_2} \delta_{2\alpha_2}(U^k) - \frac{g}{\mu_1 \Delta\alpha_1} \delta_{\alpha_1}(\eta^{k-1}) \\ & - \frac{2}{\rho\bar{d}} \left[\frac{1}{\mu_1 \Delta\alpha_1} \delta_{\alpha_1}\left(S^k_{xx}\right) + \frac{1}{2\mu_2 \Delta\alpha_2} \delta_{2\alpha_2}\left(\bar{S}^k_{xy}\right) \right] + 2\bar{\varepsilon}_x \frac{1}{\mu_2 \mu_1} \frac{1}{\Delta\alpha_2 \Delta\alpha_1} \delta_{\alpha_2 \alpha_1}(V^k) \\ & + 2\bar{\varepsilon}_y \left[\frac{1}{\left(\mu_2 \Delta\alpha_2\right)^2} \delta_{\alpha_2 \alpha_2}(U^k) + \frac{1}{2\mu_2 \left(\Delta\alpha_2\right)^2} \delta_{\alpha_2}\left(\frac{1}{\mu_2}\right) \delta_{2\alpha_2}(U^k) \right] \\ & + \frac{1}{\mu_1 \mu_2} \frac{1}{\Delta\alpha_2 \Delta\alpha_1} \delta_{2\alpha_2}(\bar{\varepsilon}_x) \delta_{\alpha_1}(\bar{V}^k) \Bigg\} \quad \text{at} \quad (n, m+1/2) \end{aligned} \tag{28}$$

$$a_{m\pm1/2} = \frac{\Delta t}{\left(\mu_1\right)_m \Delta\alpha_1} \bar{d}^k_{n,m\pm1/2} \tag{29}$$

$$A_m = \eta^{k-1} - \frac{\Delta t}{\mu_1 \Delta\alpha_1} \delta_{\alpha_1}\left(U^{k-1}\, \bar{d}^k\right) - \frac{2\Delta t}{\mu_2 \Delta\alpha_2} \delta_{\alpha_2}\left(V^{k-1}\, \bar{d}^k\right) \quad \text{at} \quad (n,m) \tag{30}$$

$$\bar{\bar{V}}^k_{n,m+1/2} = \frac{1}{4}\left(V^k_{n-1/2,m} + V^k_{n+1/2,m} + V^k_{n-1/2,m+1} + V^k_{n+1/2,m+1}\right) \tag{31}$$

17. Consider the set of cells for which the index n is constant and equal to N. Suppose at the upper boundary cell ($m = M$), the velocity $U_{N,M+1/2}$ is always known. Similarly suppose at the lower boundary cell ($m = L$) the water level $\eta_{N,L}$ is always known. Then the set of equations for all the cells may be written in the following matrix form if we drop the common subscript N :

$$\begin{bmatrix} \bar{a}_{M+1/2} & a_{M+1} & 0 & 0 & \cdots & 0 \\ -a_{M+1/2} & 1 & a_{M+3/2} & 0 & \cdots & 0 \\ 0 & -a_{M+1} & \bar{a}_{M+3/2} & a_{M+2} & \cdots & 0 \\ & & & & \cdots & \\ & & & & \cdots & \\ & & & & \cdots & \\ 0 & 0 & 0 & \cdots & -a_{L-1/2} & 1 \end{bmatrix} \begin{bmatrix} U^{k+1}_{M+1/2} \\ \eta^*_{M+1} \\ U^{k+1}_{M+3/2} \\ \cdot \\ \cdot \\ U^{k+1}_{L-1/2} \\ \eta^*_L \end{bmatrix} = \begin{bmatrix} \hat{B}_{M+1/2} \\ A_{M+1} \\ B_{M+3/2} \\ \cdot \\ \cdot \\ B_{L-1/2} \\ \hat{A}_L \end{bmatrix} \tag{32}$$

where

$$\hat{B}_{m+1/2} \equiv B_{M+1/2} + a_M \eta^*_M$$

$$\hat{A}_L \equiv A_L - a_{L+1/2} U_{L+1/2}$$

18. Since the first matrix on the left-hand side of Equation 32 is tridiagonal, the above matrix equation can be solved by recursion. In general, the recursion relations may be written as

$$\eta_m^* = -P_m U_{m+1/2}^{k+1} + Q_m \tag{33}$$

$$U_{m-1/2}^{k+1} = -R_{m-1}\eta_m^* + S_{m-1} \tag{34}$$

where

$$P_m = \frac{a_{m+1/2}}{T1} \qquad Q_m = \frac{A_m + a_{m-1/2}S_{m-1}}{T1}$$

$$R_m = \frac{a_{m+1}}{T2} \qquad S_m = \frac{B_{m+1/2} + a_m Q_m}{T2}$$

$$T1 = 1 + a_{m-1/2}R_{m-1} \tag{35}$$

$$T2 = \bar{a}_{m+1/2} + a_m P_m$$

19. Since in the FORTRAN computer language, fractional indices are not possible, a new integer index system is adopted in the program. Thus all the variables defined at the center and the faces $m+1/2$ and $n+1/2$ of a cell (n,m) will be designated by the integer indices (N,M). The only exceptions are the expansion coefficients μ_1 and μ_2 which are defined at cell centers and faces. For these, the following index system is adopted. For example, μ_1 at the center of cell (n,m) is designated by the index $2M-1$, whereas μ_1 at the face $m+1/2$ is denoted by the index $2M$, and similarly for μ_2. Using this new notation, the expanded form of the recursion coefficients for the $\alpha_1(x)$-sweep may be written as follows:

$$P_M = \frac{\Delta t \ \bar{d}_{N,M}^k}{\left(\mu_1\right)_{2M-1} \Delta\alpha_1 T1} \tag{36}$$

$$Q_M = \frac{A_M + \dfrac{\Delta t \ \bar{d}_{N,M-1}^k}{\left(\mu_1\right)_{2M-1} \Delta\alpha_1} S_{M-1}}{T1} \tag{37}$$

$$R_M = \frac{g\Delta t}{\left(\mu_1\right)_{2M} \Delta\alpha_1 T2} \tag{38}$$

$$S_M = \frac{B_M + \frac{g\Delta t}{\left(\mu_1\right)_{2M} \Delta\alpha_1} Q_M}{T2} \qquad (39)$$

where

$$T1 = 1 + \frac{\Delta t \ \bar{d}^k_{N,M-1}}{\left(\mu_1\right)_{2M-1} \Delta\alpha_1} R_{M-1} \qquad (40)$$

$$T2 = 1 + \frac{2\Delta t \cdot c < \left| \overline{u_{orb}} \right| >^k_{N,M}}{\bar{d}^k_{N,M}} + \frac{g\Delta t}{\left(\mu_1\right)_{2M} \Delta\alpha_1} P_M \qquad (41)$$

Using the same notation, the solution (Equations 33 and 34) may be written as

$$\overset{*}{\eta}_{N,M} = -P_M U^{k+1}_{N,M} + Q_M \qquad (42)$$

$$U^{k+1}_{N,M-1} = -R_{M-1} \overset{*}{\eta}_{N,M} + S_{M-1} \qquad (43)$$

For any given N , the recursion coefficients P , Q , R , and S are computed, using Equations 36-41, in succession between the boundaries in the direction of increasing $\alpha_1(x)$. The values of these coefficients at the boundaries depend on the types of boundary conditions encountered. Once all the coefficients for a given N have been determined, the values of η^* and U^{k+1} for all the cells in the column are computed, using Equations 41 and 42, in the direction of decreasing $\alpha_1(x)$. We next go to the next higher value of N , and so on until the whole grid is swept in the $\alpha_1(x)$-direction.

20. The development of the finite difference equations and the recursion relations for the $\alpha_2(y)$-sweep is similar to that for the $\alpha_1(x)$-sweep. In this case, using the same notation as before, the recursion coefficients may be written as

$$P_N = \frac{\Delta t \ \bar{d}^k_{N,M}}{\left(\mu_2\right)_{2N-1} \Delta\alpha_2 T1} \qquad (44)$$

$$Q_N = \frac{A_N + \dfrac{\Delta t\ \bar{d}^k_{N-1,M}}{\left(\mu_2\right)_{2N-1} \Delta\alpha_2} S_{N-1}}{T1} \tag{45}$$

$$R_N = \frac{g\Delta t}{\left(\mu_2\right)_{2N} \Delta\alpha_2 T2} \tag{46}$$

$$S_N = \frac{B_N + \dfrac{g\Delta t}{\left(\mu_2\right)_{2N} \Delta\alpha_2} Q_N}{T2} \tag{47}$$

where

$$T1 = 1 + \frac{\Delta t\ \bar{d}^k_{N-1,M}}{\left(\mu_2\right)_{2N-1} \Delta\alpha_2} R_{N-1} \tag{48}$$

$$T2 = \frac{1 + 2\Delta t\ c < \left|\overline{u_{orb}}\right| >^k_{N,M}}{\bar{d}^k_{N,M}} + \frac{g\Delta t}{\left(\mu_2\right)_{2N} \Delta\alpha_2} P_N \tag{49}$$

The corresponding solution may be expressed as

$$\eta^{k+1}_{N,M} = -P_N V^{k+1}_{N,M} + Q_N \tag{50}$$

$$V^{k+1}_{N-1,M} = -R_{N-1} \eta^{k+1}_{N,M} + S_{N-1} \tag{51}$$

Initial and Boundary Conditions

21. In order to solve the problem under consideration, appropriate initial and boundary conditions must be specified. For the examples reported here, an initial condition of rest was chosen so that η , U , and V are zero at the start of the calculations. To avoid shock, the radiation stress gradients were gradually built up to their full values over a number of time-steps. The numerical computation was stopped when a steady state was deemed to have been reached.

22. The numerical model permits different types of boundary conditions; among these are the following:

a. "No flow" (wall). This type of boundary condition is used at closed boundaries such as the still-water line on beach and at impermeable structures. The normal velocity is set to zero in this case.

b. Discharge. This type of condition is used by WIFM at open boundaries. The variation of discharge with time is prescribed along boundary cells. For the wave-induced current model, this condition is never used since the discharge is an unknown even at the boundaries.

c. Elevation (tide). This type of condition is used by WIFM at open boundaries. The variation of the surface elevation with time is prescribed along boundary cells. For the wave-induced current model, this condition is never used except possibly at the offshore boundary since the setup is an unknown quantity. Even at the offshore boundary, a radiation boundary condition was found to be preferable.

d. Uniform flux. In this type of open boundary condition, the flux at a boundary cell is made equal to that at the next interior cell. Thus the condition assumes $\partial(Ud)/\partial x = 0$ or $\partial(Vd)/\partial y = 0$ at the boundary. This type of condition is used for the lateral boundaries since it is a passive condition.

e. Radiation. This open boundary condition requires that any transients developed initially inside the numerical grid should propagate out of the grid as gravity waves. It is of the form $\partial\eta/\partial t + C(\partial\eta/\partial x) = 0$ where C is the phase speed of a surface disturbance $\eta(x,t)$. It is often used by the wave-induced current at the offshore boundary and is found preferable to a wall or constant elevation condition there. Both of the latter conditions are highly reflective and as a result the transients tend to bounce back and forth between the offshore and nearshore boundaries and take a long time to damp out. On the other hand, the radiation condition seems to work quite well and allows the transients to propagate out of the grid which permits the setdown at the offshore boundary to assume an appropriate value.

23. The boundary conditions frequently used in the wave-induced current model are illustrated in Figure 4.

24. At present, the model allows for subgrid barriers such as jetties, provided they are impermeable and nonovertopping. The program essentially sets to zero the velocity component normal to the appropriate cell face.

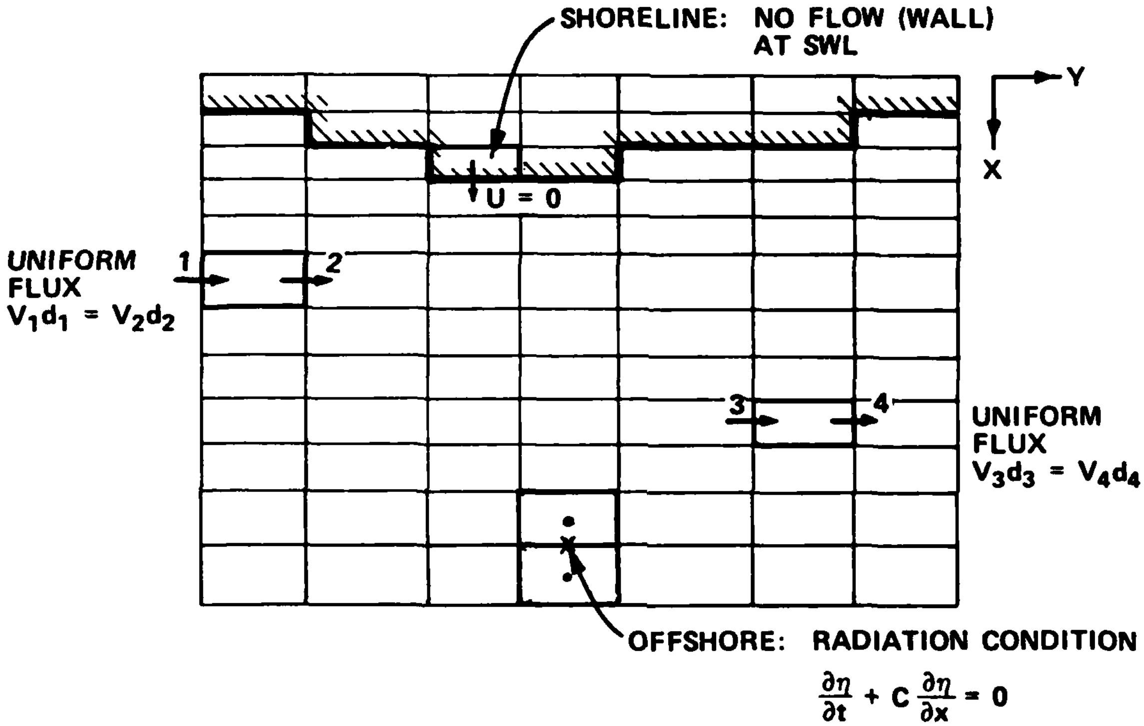

Figure 4. Boundary conditions used in numerical model CURRENT

PART IV: VALIDATION OF MODEL

Tests for Idealized Conditions

25. To develop confidence in the validity of the model and the accuracy of its results, several tests were run on the model and comparisons were made between model results and available laboratory data and analytic solutions. All of these tests were for plane beaches, for which the coordinate scheme is chosen such that the y-axis coincides with the still-water line in beach and the x-coordinate is measured from the still-water line (Figure 5). Note that for plane beaches, there is no variation in the alongshore (y) direction.

Plane beach: normal incidence

26. The model was run for a case of normal incidence on a plane smooth laboratory beach, reported by Bowen, Inman, and Simmons (1968). The conditions were as follows: $T = 1.14$ sec, deepwater wave height $H_o = 6.45$ cm, and beach slope $s = 1{:}12$. To run this case on the model, a variable rectangular grid with overall dimensions of approximately 40 m by 30 cm (the laboratory channel was 40 m long) was used with $\Delta\alpha_1 = \Delta\alpha_2 = 10$ cm and $\Delta t = 0.05$ sec. The grid was 3 cells wide in the alongshore direction and 50 cells long in the offshore direction. In this example, walls were used for the lateral boundaries as well as the offshore boundary to correspond to the laboratory situation. Since for normal incidence, the velocities U and V would be zero everywhere corresponding to the steady state, advection, eddy viscosity, and friction terms were turned off in the model. The solution allowed for the effect of setup on the wave heights in the surf zone. As the solution proceeded, since $\bar{\eta}$ changed, the wave heights for cells in the surf zone were computed afresh for each time-step by using $H = \gamma(|h| + \bar{\eta})$, where γ is a breaking index and the radiation stresses were changed accordingly. As suggested by Bowen, Inman, and Simmons (1968), a γ of 1.15 was used. A buildup time of $10\ \Delta t$ was used at the start. A comparison of the steady-state setup values from the model (after $150\ \Delta t$) with those observed by Bowen, Inman, and Simmons (1968) is shown in Figure 6. As shown, there is excellent agreement in the offshore region. In the surf zone, the numerical model predicts higher setups than those observed. This is not surprising since the model does not allow flooding and runup. It is to be noted that the slope of the mean waterline in the surf zone is approximately the same in both cases.

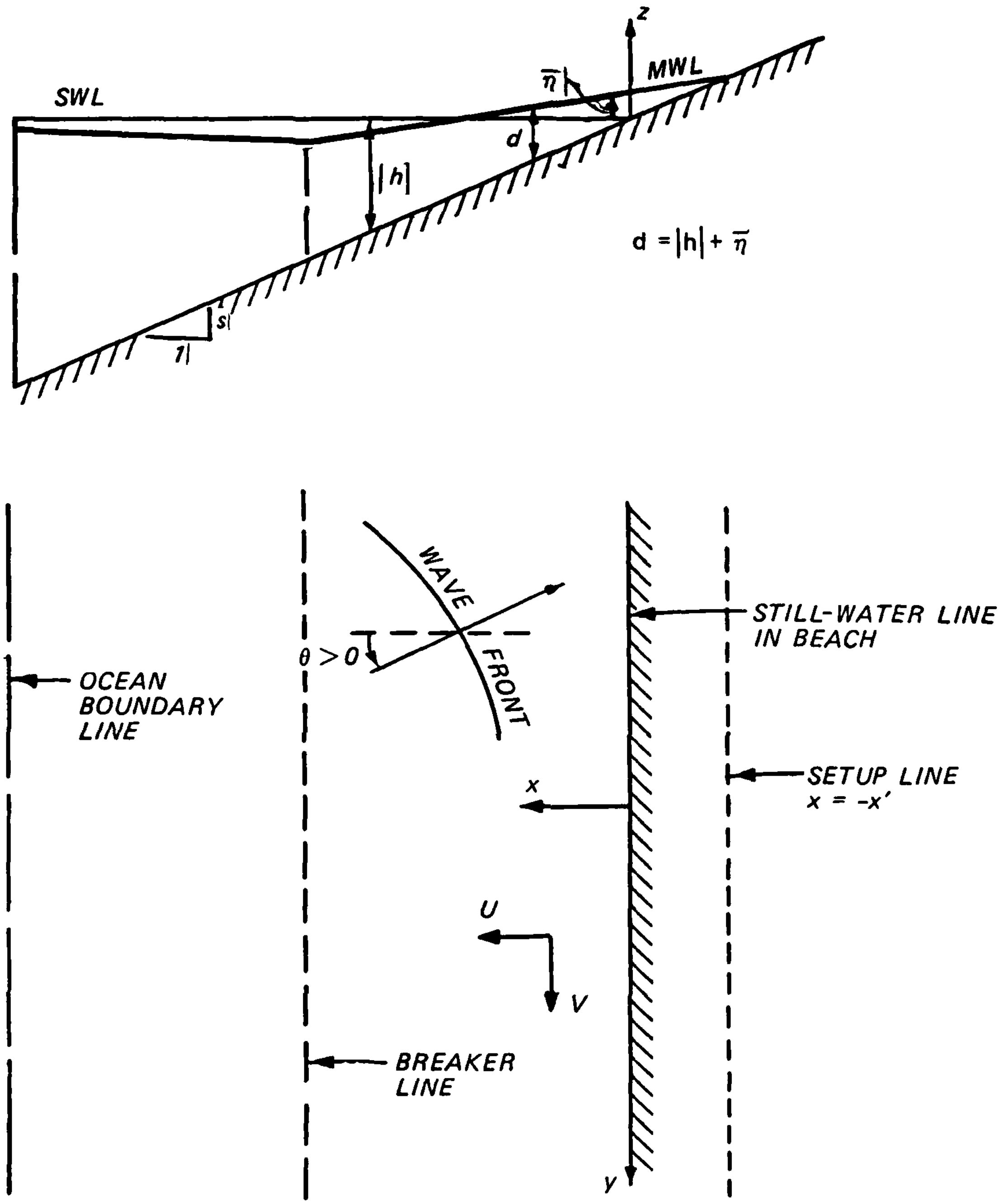

Figure 5. Definition sketch for a plane beach: cross section and plan

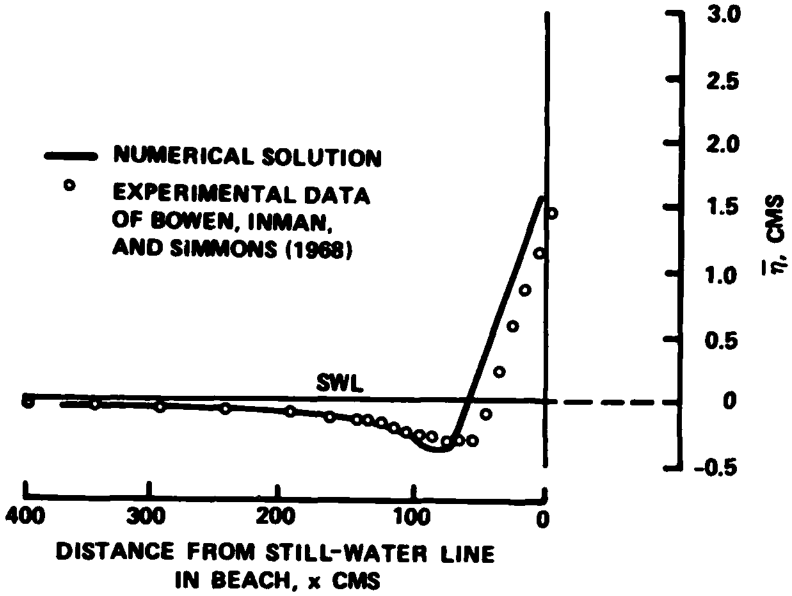

Figure 6. Comparison of numerical solution for setup with experimental data

Plane beach: oblique incidence

27. For this case, a plane beach of constant bottom slope $s = 1{:}30$ was selected. A monochromatic wave with the following deepwater characteristics was chosen: $T = 12$ sec, $H_o = 10$ ft, and angle of incidence in deep water, $\theta_\infty = 20$ deg. A drag coefficient c of 0.01 and a breaking index γ of 0.82 were used in the model. A uniform grid with $\Delta x = \Delta y = 60$ ft was used for most of the runs. It was 6 cells wide in the alongshore direction and 100 cells long in the offshore direction. Uniform flux and radiation boundary conditions were used for the lateral and offshore boundaries, respectively. The buildup time varied from 15 to 50 Δt, depending on the time-step Δt used.

28. First the model was run without allowing for the effect of setup on wave heights and radiation stresses. Mixing and advection were ignored. A time-step of 0.5 sec was used. The steady-state velocity distribution obtained (after 800 Δt) is compared with the triangular distribution of Longuet-Higgins (1970) in Figure 7. There is good agreement. Note that for positive θ, V will be negative for our coordinate scheme. Later a finer grid ($\Delta x = \Delta y = 30$ ft) with a Δt of 0.25 sec was used. As shown in Figure 7, as the grid is made finer, the numerical solution tends to approach the analytic solution.

29. The effect of setup was taken into account next. A time-step of

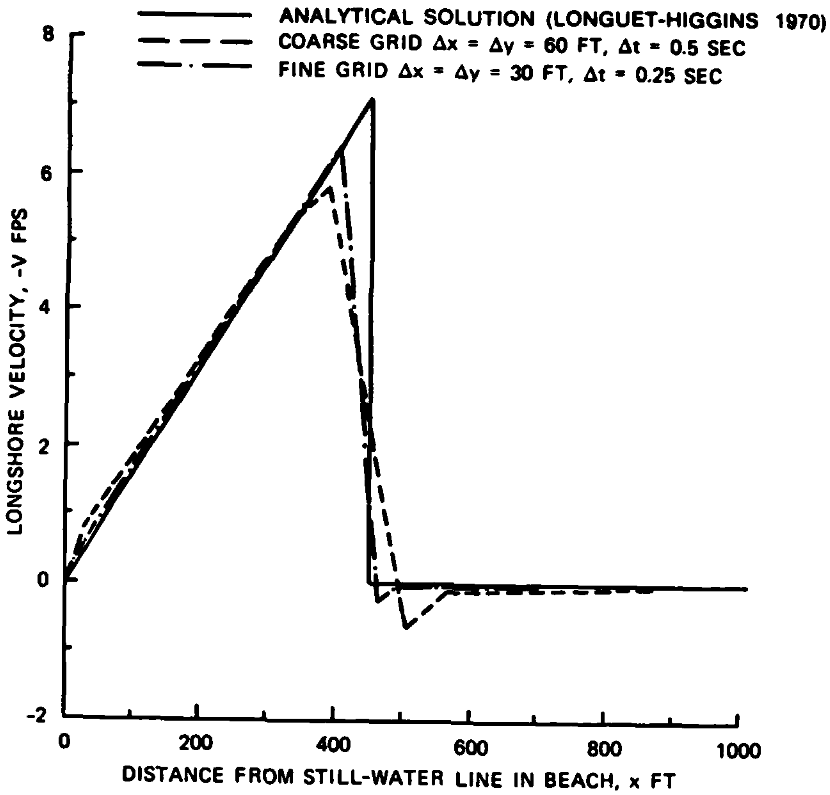

Figure 7. Plane beach: solution for longshore current neglecting the effect of setup

1.5 sec was used for this case. The velocity distribution from the model is compared with the corresponding analytic solution in Figure 8. There is good agreement. Note that the numerical solution goes to zero at the still-water line because a wall was assumed there. On the other hand, the Longuet-Higgins (1970) solution goes to zero at the setup line. To plot his solution, the distance from the still-water line to the setup line was estimated by using a relation provided by Dalrymple, Eubanks, and Birkemeier (1977).

30. The effect of lateral mixing was studied next, without taking the effect of setup into account. A time-step of 5.0 sec was used for these runs. The mixing parameter P of Longuet-Higgins (1970) was varied between 0.01 and 0.4. Note that P is defined as

$$P = \frac{\pi}{\gamma} \frac{sN_{LH}}{c} \tag{52}$$

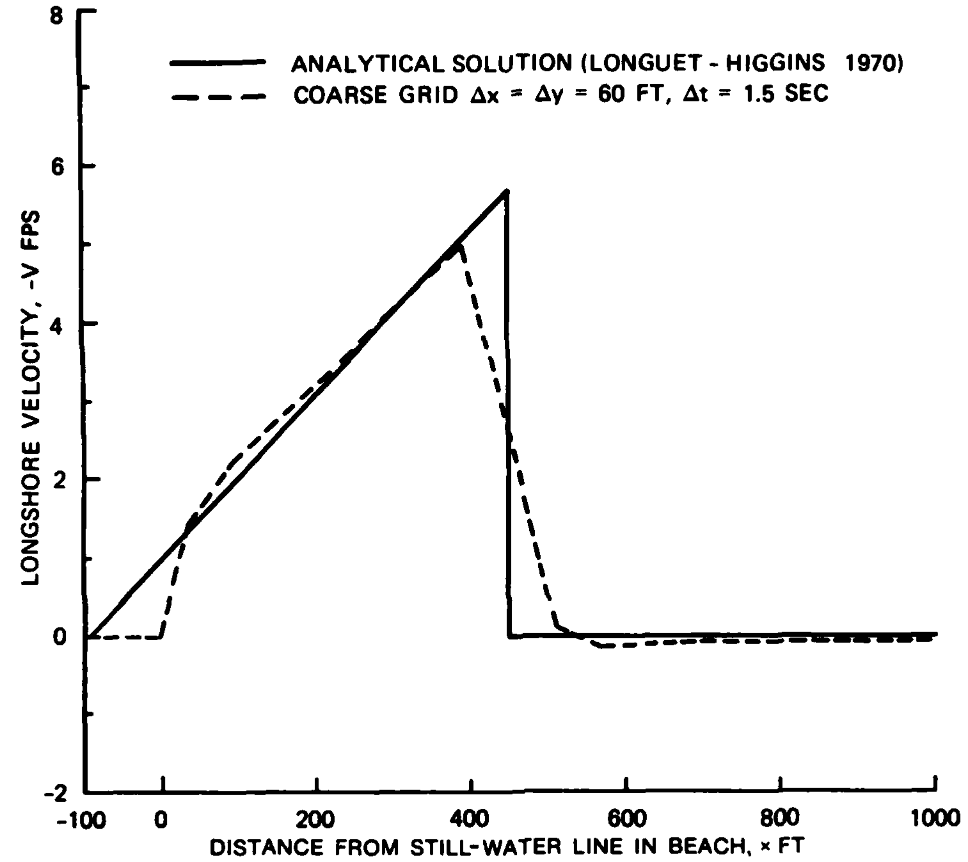

Figure 8. Plane beach: solution for longshore current considering the effect of setup

Figure 9 shows the effect of P on the numerical solution. As expected, the magnitude of the peak decreases, the peak moves closer to the shoreline, and the velocities offshore of the breaker line increase as P increases.

Difficulties Involved in Application to Field Situations

31. While it is relatively easy to apply a numerical current model to idealized cases, one must face several difficulties in applying the model to field situations. Among these is the highly irregular nature of the bathymetry, especially near inlets where channels and shoals exist. The topography must be smoothed to a certain extent in order for the wave climate and wave-induced current models to work properly; yet, one must be careful not to completely change the basic features of the topography. The shoreline as well as the breaker line may be irregular and may be oblique to the grid axes. There

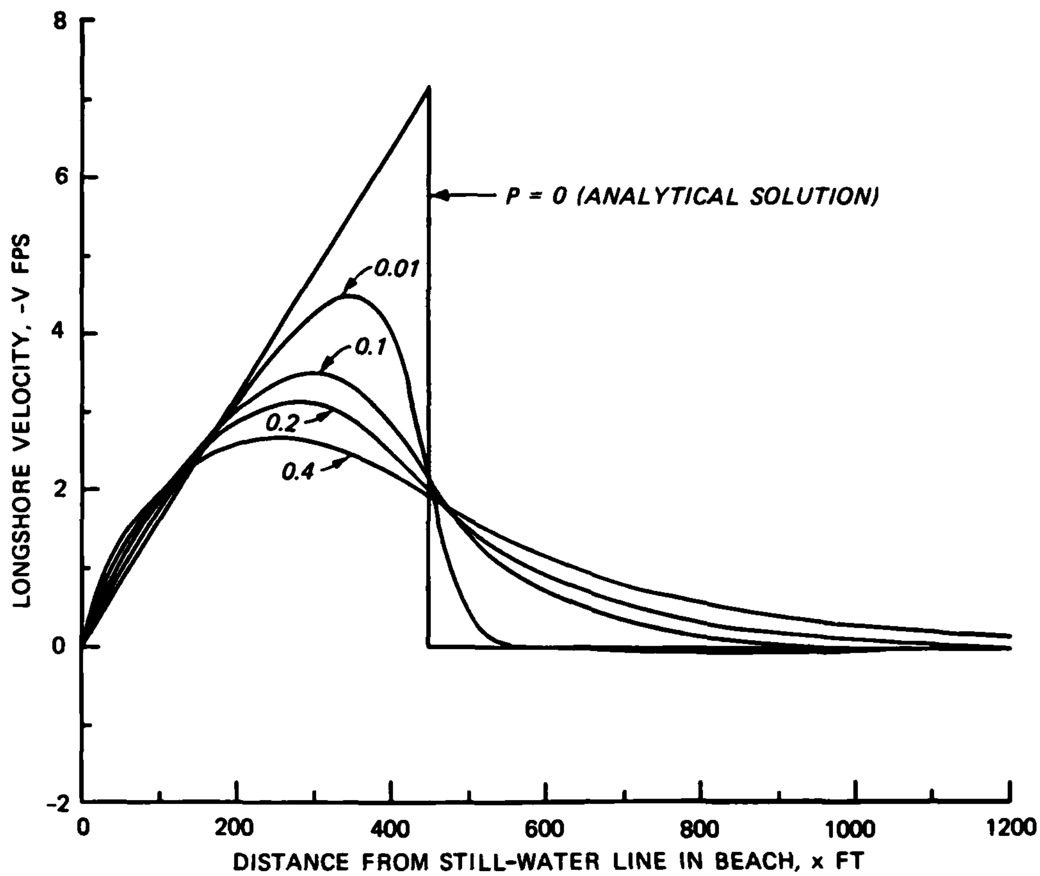

Figure 9. Plane beach: effect of mixing parameter P on the numerical solution

may be more than one breaker line. There are problems connected with discretization of the shoreline and breaker line(s). Selection of appropriate values for empirical coefficients such as friction and eddy viscosity coefficients and breaking index is not easy. There are problems in connection with the wave climate model also, especially if wave-current interactions are to be taken into account.

A Particular Field Application

32. In order to demonstrate the applicability of the numerical model to field situations, the case of Oregon Inlet, North Carolina, was selected. Oregon Inlet is a tidal inlet in a barrier island system. Behind the inlet toward the mainland is Pamlico Sound. Most of the problems mentioned in the previous paragraph had to be addressed and solved satisfactorily in this

application. For purposes of the numerical simulation, a rectangular region approximately 62,400 ft long in the alongshore direction and 29,400 ft wide in the offshore direction was considered. It included a portion of Pamlico Sound. The variable grid used for the simulation is shown in Figure 10. The grid was

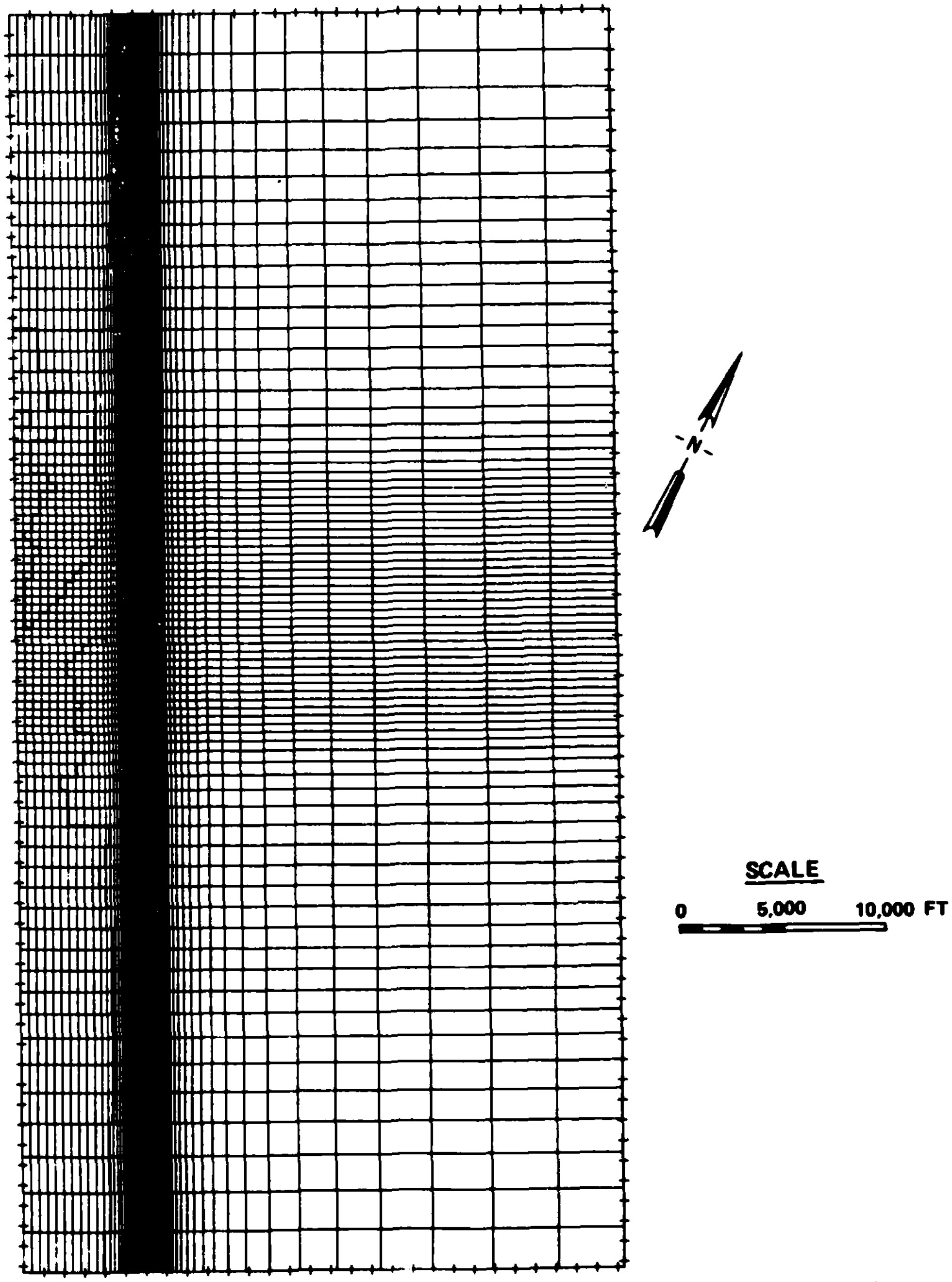

Figure 10. Numerical grid used for Oregon Inlet, North Carolina, simulation

77 cells long in the alongshore direction and 54 cells wide in the offshore direction. It may be noted that the minimum cell widths in the alongshore and offshore directions were 400 and 100 ft, respectively. These widths were used near the inlet and surf zone, respectively. Note that $\Delta\alpha_1 = \Delta\alpha_2 = 100$ ft. The topography used in the simulation corresponding to this grid is shown in Figure 11. The elevations are shown in feet and the datum is mean low water (mlw). Several points must be mentioned about this three-dimensional perspective plot. First, the vertical dimensions are highly exaggerated compared with the horizontal; secondly, the elevations are plotted in the computational space and not the physical space--so the horizontal dimensions are distorted. The topography was somewhat modified compared with the actual topography, with respect to the depths near the offshore boundary and the land elevations on the islands. In spite of these factors, Figure 11 helps one to visualize the irregular nature of the bathymetry. Also, the locations of the channels and shoals in the region of the inlet are shown clearly in the figure.

33. A monochromatic wave with a height of 11.39 ft, period of 8.0 sec, and $\theta = 51.1$ deg in 60-ft depth of water was selected for the simulation (the depth of water at the offshore boundary of the numerical grid was 60 ft). This wave corresponded to the significant wave during a part of the Ash Wednesday storm of March 1962 at the inlet. In this case, besides using "no flow" conditions at the shoreline, a radiation boundary condition offshore, and uniform flux boundary conditions at the lateral boundaries, a uniform flux boundary condition was used over a part of the inland side of the sound, while the rest of the sound was closed off. A time-step Δt of 18.0 sec and a drag coefficient c of 0.01 were used in the numerical model. The breaking index γ was chosen according to the breaking criterion employed by Noda (1974):

$$\frac{H_b}{L_b} = 0.12 \tanh\left(\frac{2\pi d_b}{L_b}\right) \tag{53}$$

where L corresponds to the wavelength and the subscript b indicates values at breaking. A buildup time of $15\ \Delta t$ was used at the start. The eddy viscosity ε_x was chosen according to Equation 14 and the eddy viscosity ε_y was set equal to the value of ε_x at the offshore boundary. For the case under consideration, the complete equations (Equations 1, 2, and 3) were solved. An approximate steady state was reached after $67\ \Delta t$. Figures 12 and 13 represent

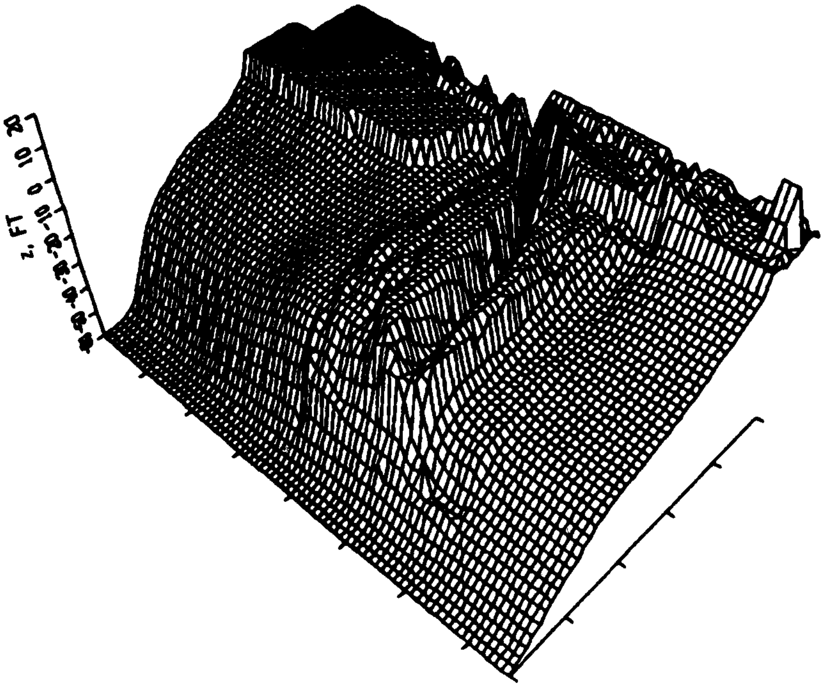

Figure 11. Topography used for Oregon Inlet, North Carolina, simulation

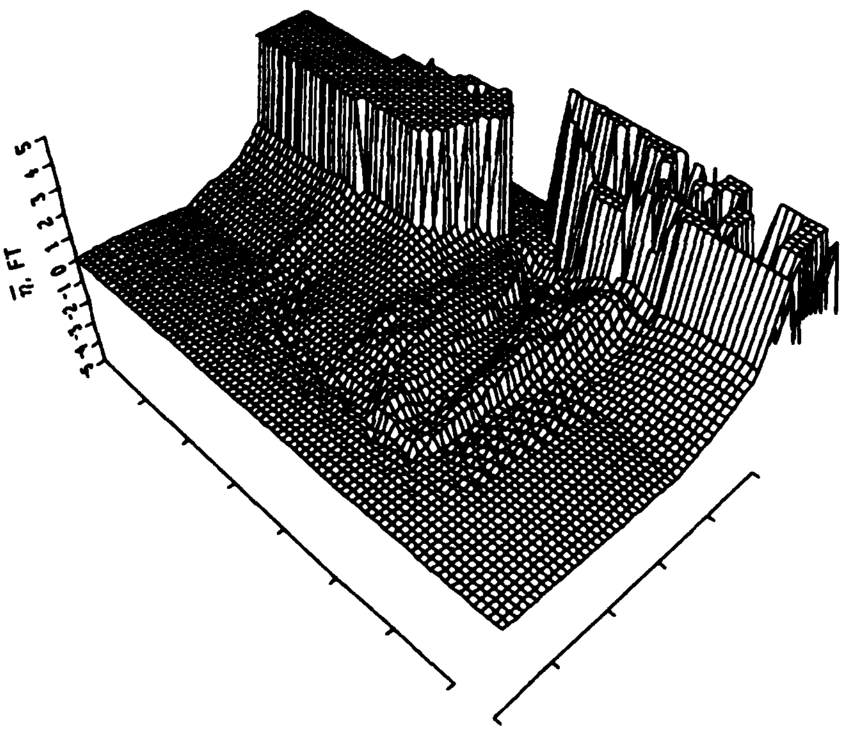

Figure 12. Water-surface elevation plot for Oregon Inlet, North Carolina, simulation

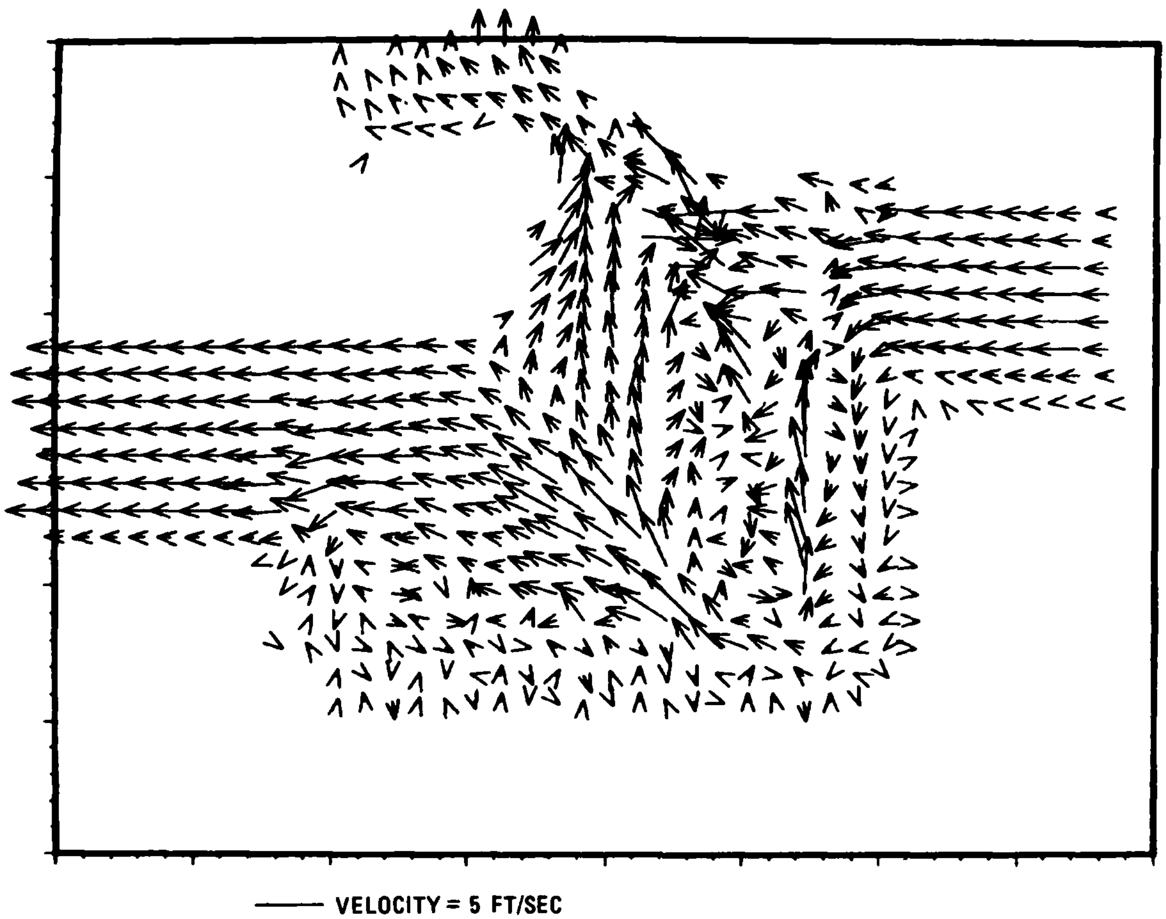

Figure 13. Velocity vector plot for Oregon Inlet, North Carolina, simulation

the corresponding mean water levels and velocity vectors plotted on the grid in the computational space. The velocity vectors are plotted for every other cell in each coordinate direction. To avoid confusion, the plotting of velocities with magnitudes less than 0.1 ft/sec is suppressed.

34. Referring to Figures 11, 12, and 13, let us first consider the two portions of the beach away from the inlet. The shorelines in these regions are approximately straight and the contours are approximately straight and parallel. As we approach the shoreline from offshore, there is a small setdown followed by a setup. The velocities are mainly alongshore and the velocity distribution is similar to that for a plane beach except that it exhibits two peaks at some locations.

35. The situation is more complicated in the region of the inlet (the central part of the grid). Here the breaker line is farther offshore. The

depth in the main channel decreases first and increases later as we go toward the inlet. Because of these factors, the water sets up around the inlet and tends to create a flow into the inlet through the various channels, as one would naturally expect. A part of the main alongshore flow goes around the channels and shoals to the other side.

36. Near the shoals, the patterns of mean water level and velocity are irregular. This is because the waves refract around the shoals and break, creating locally setups and currents that do not necessarily conform to the general patterns. As the waves go toward the islands, they re-form because the depth increases.

37. Figures 12 and 13 do not reflect the influence of tides and freshwater flows through the inlet. In nature, these phenomena tend to modify the patterns shown in these figures.

Summary

38. The various tests for idealized situations and the successful comparisons to analytic solutions and experimental data indicate that the numerical model "behaves properly" and yields valid and accurate results. In the case of the field situation for Oregon Inlet, there are no field data available with which the model results can be compared. However, for this very complicated case, the model yields results that appear to be reasonable.

PART V: MODEL INPUT

General Description

39. The input data for CURRENT are discussed in this part. The model has been tested using the foot-pound-second system of units only. The number of time-steps computed is indicated by an integer variable ITIME. The grid index system is set up with N approximately in the alongshore direction and M increasing in the offshore direction. If a variable grid is used, the expansion coefficients must be defined for both cell centers and cell faces and are obtained from the programs MAPIT and GRID developed at WES.

Setting Matrix Dimensions

40. In the CRAY computer system on which the model was developed, matrix dimensions are changed for a particular application by using PARAMETER cards. The following parameters must always be set. This is done by using the UPDATE feature of CRAY. Using text editor, the following statements in *ID PARMRUN in update file UPDL2RV should be changed appropriately for the application:

```
PARAMETER(NDIM=   , MDIM=   , LDIM=   , IFRC=   )
PARAMETER(IPUT=   , ITDS=   , JPUT=   , JFLS=   )
PARAMETER(NGAGES=   , NBCELS=   , NBARCL=   )
```

The significance of the various parameters is explained below. Normally, only the parameters marked with an asterisk have to be changed. The rest may be left at the values given with the program.

NDIM* = Grid dimension (number of cells) in y-direction

MDIM* = Grid dimension (number of cells) in x-direction

LDIM* = Larger of NDIM and MDIM

IFRC* = Dimension of friction array for Chezy values ($\geq$4*DMAXG, where DMAXG is the maximum total water depth (ft) that will be experienced anywhere in the grid during the numerical simulation)

IPUT* = Dimension of elevation (tidal) forcing array--array must include a value for each time-step

ITDS* = Number of different elevation (tidal) forcing arrays

JPUT = Dimension of discharge forcing arrays

JFLS = Number of different discharge forcing arrays

NGAGES = Number of special gage locations for which results are to be printed

NBCELS* = Number of boundary cells (where boundary conditions are to be applied)

NBARCL* = Number of barrier cell faces

Input Data

41. The input data for CURRENT have been assembled into card groups that may consist of one or more data cards. Some groups are optional and thus each group is marked with an R (required) or O (optional). The following text indicates for each input card group the necessity code, FORTRAN format, the variables involved, and a brief description of the variables.

Necessity Code	Card Group (Format)	Variable	Description
R	1A (I5)	NDTAP	Number of file from which input data are to be read in--usually set to 95

NOTE: All the following card groups are on a separate file defined by NDTAP (if NDTAP≠5). Group 1A must be on the system input file (File 5, i.e. card reader)

Necessity Code	Card Group (Format)	Variable	Description
R	1B (8A8)	ITL	Identification title for run
R	1C (NAMELIST $WAVE)	PER	Period of the wave
		HTO	Wave height at the offshore boundary--used for calculating ε_y
		THETAO	Angle of incidence of waves (in degrees) at the offshore boundary, measured with respect to the x-axis--used for calculating ε_y
		DEPMAX	Depth at the offshore boundary (ft)--used for calculating ε_y
		GAMMA	Breaking index (ratio of wave height to depth in surf zone)
R	2 (3I5)	NMAX	Grid dimension (number of cells) in y-direction
		MMAX	Grid dimension (number of cells) in x-direction

Necessity Code	Card Group (Format)	Variable	Description
R	3 (16I5)	ITID	Number of entries in input elevation (tidal) table
		JTID	Number of time-steps between entries in input elevation (tidal) table
		NTID	Number of distinct elevation (tidal) forcing functions
		MPR	Print control for initial conditions 1--print flag arrays only 2--print depth also <0--print in addition flood, barrier, and elevation (tidal) data
		MSURF	Print elevation (tidal) forcing function in steps of MSURF
R	4 (8E10.1)	TAU	Time-step, Δt (sec) for one full cycle
		DX	Cell dimension $\Delta\alpha_1$ (ft)
		DY	Cell dimension $\Delta\alpha_2$ (ft)
		G	Acceleration due to gravity (ft/sec^2)
		EPSD	Minimum amount of water defining a dry cell (ft)
		DCON1	Add DCON1 to water cell bed elevations to translate datum (ft)
		DMPX	Value of still-water land elevation assigned artificially to areas that will never flood (ft)
		VIS	A multiplier for eddy viscosity terms (can be set between 0 and 1)
		XLAND*	A value of bed elevation, h >XLAND defines a cell that will never flood (ft) (positive)
		XSCOUR*	A value of h < XSCOUR defines a cell that will never go dry (ft) (negative)
		SMAX	If η > SMAX , stop computations and print η ; caution: set SMAX higher than highest land cell elevation
		DMAXG	Positive bound on maximum total water depth that will be experienced during simulation (ft)--used for setting up size of friction matrix

* Caution: Select XLAND< bed elevation of lowest land cell and XSCOUR < depth $|h|$ of shallowest water cell if flooding/drying is not desirable. The flood/dry capabilities of the program have not been tested.

Necessity Code	Card Group (Format)	Variable	Description
R (Continued)	4 (8E10.1) (Continued)	DCON2	Add DCON2 to elevation (tidal) input values to correspond to model datum (ft)
		DLIMIT	Artificial cutoff value on bed elevation (h) for water cells (negative) (ft)
R	5 (16I5)	MAXTIM	Number of time-steps to run simulation
		INTAP	=m--save $\bar{\eta}$, U and V on file 1 every $m\Delta t$ =-1--no data are saved on file 1
		IDELAY	Delay saving information on file 1 until ITIME= IDELAY (note ITIME counts the number of cycles)
		IXPAN	=0 uniform grid in real space ≠0 variable grid--read in expansion coefficients
		NGAGE	Number of special gage points (up to 20 gages are permitted)
		NFREQ	Information will be printed at gage points every NFREQ Δt's--never set equal to zero!
		NZP	Number of corrections to input depth matrix
R	7 (16I5)	NPRINT	Time-step index to print hydrodynamics (η , U , and V) over the whole grid--up to 32 printouts are allowed--two cards must be included
O	8 (16I5)	NPOT	y-indices for special gage points (NGAGE in number)
		MPOT	x-indices for special gage points (NGAGE in number)--start on a new card

Note: Group 8 is omitted if NGAGE=0

Necessity Code	Card Group (Format)	Variable	Description
R	12 (10F8.3)	$XMAN_i$	Mannings's n for each code i, i=1,20--used for defining friction. Note: code 1 is used for all water outside computational boundaries--two cards must be included
		ZB	Heights (ft) for barrier cells (see card group 17)--start on a new card--two cards must be included
		CB	Chezy coefficients for barrier cells (see card group 17)--start on a new card--two cards must be included

Necessity Code	Card Group (Format)	Variable	Description
O	13 (2I5,F8.3)	N M DNM	Corrections to bed elevation matrix--grid indices N,M and corrected bed elevation DNM (ft)--NZP cards must be provided
			Note: Group 13 is omitted if NZP=0
R	14 (20I4)	$ISHORE2_N$	Matrix indicating shoreline position--for each N, read an M value corresponding to the last (seaward) land cell between beach and ocean. There are NMAX values
		$IBRK1_N$	Matrix indicating first breaker line position--for each N, read an M value corresponding to the breaker line
		$ISHORE3_N$	Matrix indicating a fictitious shoreline position for a second surf zone
		$IBRK2_N$	Matrix indicating second breaker line position
			Note: If there is no second surf zone, set all the values of ISHORE3 and IBRK2 to zero
R	15 (35I2)	$MAN_{N,M}$	Friction codes (1 to 20)--for each N, read $MAN_{N,M}$, M = 1, MMAX (start a new card for each N)--use special code of 99 for all water cells outside of computational boundaries--code 99 corresponds to XMAN(1)
R	17 (3I2,4I4)		Used for boundary data
		ITYP	1--impermeable nonovertopping barrier 8--elevation (tidal) input boundary (used for radiation boundary) 9--flow input boundary (used for uniform flux boundary) 99--end of group 17 data
		INDX	0--for flux boundary 1,2,3--used for indicating different elevation (tidal) boundaries
		IDIR	1--if flow or elevation (tide) is in the x-direction 2--if flow or elevation (tide) is in the y-direction
		I1	Grid index (M or N value) of boundary line
		I2 I3	Boundary extends from N or M = I2 to I3

Necessity Code	Card Group (Format)	Variable	Description
R (Continued)	17 (3I2,4I4)	I4	0--for top or left boundary (low values of x or y) 1--for bottom or right boundary (high values of x or y)
		Note:	The termination of boundary data (group 17) is indicated by including at the end of the group a card containing 99 in columns 1 to 2. All other columns should be blank
O	20 (10F8.4)	$SURIN_i$	Entries in input elevation (tidal) tables--there are NTID tables and for each table, there are ITID entries--the order in which the tables are read in depends on the sequence of the elevation (tidal) boundaries in group 17--start each table on a new card
	Note:	For radiation boundary, set ITID = 2, JTID > MAXTIM and $SURIN_1 = SURIN_2 = 0$.	
		Note: Group 20 is omitted if NTID = 0	
R	23 (16I5)	JDELAY	Delay saving gage information until ITIME = JDELAY
R	32 (NAMELIST $PAR)	RHO	Density of seawater (slugs/ft^3)--usually set to 1.99
		EY	Eddy viscosity ε_y (ft^2/sec)
		RAD	A weighting factor (between zero and one) for radiation stress gradient terms
		NTIMEB	Number of time-steps over which radiation terms are to be built up
		ADV1	A weighting factor (between zero and one) for advection terms
		FRC1	A weighting factor (between zero and one) for bottom friction terms
		ANLH	The parameter N_{LH} in Longuet-Higgins expression for eddy viscosity (Equation 13)--varies between 0 and 0.016
		CF	Drag coefficient c in the Longuet-Higgins linear relation for bed friction
		ITAVG	Number of time-steps over which the solution (values of η , U , V , and discharges) is to be averaged. The program averages the solution starting with values from step MAXTIM-ITAVG + 1. These values are printed as well as saved on appropriate files

Necessity Code	Card Group (Format)	Variable	Description
R	33 (I2)	IEDDY	Index which indicates method of computing eddy viscosity ε_x 1 = Longuet-Higgins method 1 = Jonsson et al. method 3 = eddy viscosity ε_x is read in from file 40
O	34 (16F5.0)	$XDIST_{N,M}$	The matrix containing the distance from the shoreline to each cell for use in Longuet-Higgins formula for eddy viscosity ε_x . For each value of N, read MMAX values. Start each new N on a separate card. Note: For water cells offshore of breaker line, keep XDIST same as the value at the breaker line

Input Files

42. In Boeing Computer Services (BCS), the source deck for the program is on file WIFMSRC. It has to be updated first and a program library created. Then the program library should be updated again with the update file UPDL2RV.

43. The following input data files are often used. Some are optional depending on the run.

File FT 35

44. This file contains the wave data, usually the output from a numerical wave climate program. For each grid cell, the wave number AK, wave angle TH, and the wave height HT are read in sequence. The following statements are used to read the file in subroutine DEPTH:

```
          DO   10060  M=1, MMAX
          DO   10060  N=1, NMAX
          I = NMAX*(M-1) + N
          READ (35,10061) AK(I), TH(I), HT(I)
    10060 CONTINUE
    10061 FORMAT (F10.6, 2F10.3)
```

Note that in the program the same matrix may be used either as a double index, e.g., AK(N,M) or a single index, e.g., AK(I) array. The conversion from the two index to one index system is accomplished by the relation

I = NMAX*(M-1) + N

This file is always required.

File FT 36

45. This file contains the bed elevations D(N,M) for grid cells. The following statements are used to read the file in subroutine DEPTH:

```
          DO  99005  M=1,MMAX
          READ (36,99001) (D(N,M), N = 1,NMAX)
    99001 FORMAT (10F8.3)
    99005 CONTINUE
```

Note: Usually, if SWL is taken as the datum,

D(N,M) < 0 for water cells

> 0 for land cells

This is a required file.

File FT 39

46. This file contains the grid expansion coefficients YNU and XMU for a variable grid. They correspond to μ_2 and μ_1, respectively. There will be NYY = 2* NMAX values of YNU and NXX = 2*MMAX values of XMU. These coefficients are provided by a special program called GRID. The following statements are used to read the file in subroutine INTAKE:

```
          READ (39,99002) (YNU(I), I = 1,NYY)
          READ (39,99002) (XMU(I), I = 1,NXX)
    99002 FORMAT (4G20.11)
```

This file is optional and required only for a variable grid (IXPAN ≠ 0).

File FT 40

47. This file contains the eddy viscosity coefficients for the x-direction, EX. The following statements are used to read the coefficients in a string in subroutine EDDYVIS:

```
        READ (40,115) (EX(I),I = 1,NMX)
    115 FORMAT (16F5.1)
```

This file is optional and required only if IEDDY = 3.

File FT 95

48. This is a "card image" file. It contains the rest of the input data needed for running the program. The number of the file (NDTAP) may be other than 95. The number should be indicated always on the first input data card (card group 1A). This file is required.

PART VI: MODEL OUTPUT

General Description

49. This section describes the general output in the form of printed output and output files that may be obtained from the model and the controls one may exercise on the same. Most of the input data are printed as soon as they are read in so that errors in the input data may be easily detected and corrected by the user. By setting the variable MPR (card group 3) appropriately, the user may obtain as much information as he or she desires on the flag arrays, depths, flood, barrier, and tidal data. Similarly, by using the NPRINT (card group 7) option, the user may obtain detailed printout of $\bar{\eta}$, U , and V over the whole grid at intermediate times during the computation. By using the variables NGAGE, NFREQ, NPOT, and MPOT (card groups 5 and 8), the user may provide for special gages at several locations within the grid and obtain a time-history of water levels and velocities there either to check the results of the model or to compare model results with actual field gage data. The user must provide the necessary Job Control Language (JCL) to print the files FT 07 and FT 08. By setting the variable ITAVG (card group 32), the user may obtain a solution that is averaged over the last ITAVG time-steps. The program prints the averaged water levels and velocity components at the cell centers as well as the discharges across cell faces and stores them on file FT 20 for later use in a sediment transport model.

50. Program CURRENT constructs various arrays and tables packed with data to control double-sweep computation, forcing boundaries, barrier treatment, etc. There are two flag arrays ICU(N,M) and ICV(N,M) to control computation in x- and y-directions, respectively. Each element of ICU (ICV) consists of two digits: n_1n_2 . When the flags are printed, for any given cell (N,M) the values of ICU and ICV are printed together as a four-digit number ICF. The first digit n_1 in ICU (ICV) defines the character of the cell on the bottom (right) face of the cell. Digits n_1 and n_2 have the following significance:

n_1	Definition
1	Bottom (right) face of cell is an exposed barrier that cannot be overtopped. n_2 has no meaning. Note: The code ICU=10, ICV=10 is set by the program to indicate water cells outside computational boundaries.

(Continued)

n_1	Definition
5	No flow through bottom (right) face of cell. n_2 is set to zero.
6	Flow through bottom (right) face of cell. n_2 indicates the type of computation to use for advection. $n_2 = 0$ means no advection, $n_2 = 1$ advection in x-direction only, $n_2 = 2$ advection in y-direction only, and $n_2 = 3$ advection in both x- and y-directions.
7	Constructed by the program to indicate no computation for x-(y-) sweep. n_2 is set to zero to indicate a lower boundary, and 1 for an upper boundary, for the other sweep direction.
8	Elevation (tidal) or radiation boundary cell. n_2 indicates the number of the forcing elevation (tide) used.
9	Bottom (right) face is a discharge boundary. $n_2 = 0$ indicates a uniform flux boundary condition applied at cell center; otherwise n_2 indicates the number of the forcing discharge used.

Forcing elevation (tidal) boundary control vectors take the form:

Vector i : 1000000*INDX+1000*N+M

and discharge boundary vectors the form:

Vector i : 1000000*(INDX+10*IDIR)+1000*N+M

where i is the i^{th} element of the vector, N and M are indices of the grid cell and INDX and IDIR are defined in card group 17. The user is urged to set MAXTIM=0 (card group 5) and MPR=-1 (card group 3) during the first run to check the accuracy of the input data, the flags, boundary vectors, etc. Once these are found to be correct, then MAXTIM and MPR may be set to desired values and the actual computations may be performed.

Output Files

51. Output may be stored by the model in the following files. Some are optional. The user must dispose the files with proper JCL if he or she wants to save the files for later use.

File FT 01

52. This file contains the bed elevations h , and $\bar{\eta}$, U , and V saved every INTAP time-steps in subroutine POUT. The reader is referred to that subroutine for details.

Files FT 07 and 08

53. These contain the results $\bar{\eta}$, U , and V for selected gages (see

card groups 5 and 8) stored at intervals of NFREQ, starting from time-step JDELAY. Each file contains information for up to 10 gages. It is convenient to copy these files to system OUTPUT file at the end of the run. The results will then be printed in a tabular form. Files FT 07 and FT 08 are written on in subroutine DRIVE.

File FT 11

54. This file contains the surface elevation $\bar{\eta}$ and the velocities U , V (averaged, respectively, at the center of the cell) for the special gage locations in a form that is convenient for plotting time series. The results are stored at intervals of NFREQ, starting from time-step JDELAY, using the following statements:

```
            DO   10020  J=1, NGAGE
            N = NPOT(J)
            M = MPOT(J)
            II = NMAX*(M-1)+N
            ...     ...
            WRITE(11)ITIME,J,N,M,SEP(II),UU,VV
      10020 CONTINUE
```

where ITIME is the time-step number. This file is written on in subroutine DRIVE.

File FT 13

55. This file contains the surface elevations all over the grid at selected instants of time NPRINT during the course of the computation. The file is written on in subroutine POUT using the following statements:

```
           WRITE(13) ITIME
           DO  4800   M=1,MMAX
           DO  4800   N=1,NMAX
           I1 = (M-1)*NMAX+N
           WRITE(13)SEP(I1)
      4800 CONTINUE
```

This file may be used for 3-D plotting.

File FT 14

56. This file contains the velocities U , V at the center of each grid cell for all the grid cells at selected instants of time NPRINT during the course of the computation. The file is written on in subroutine POUT using the following statements:

```
      WRITE(14)ITIME
      DO 4900  M=1,MMAX
      DO 4900  N=1,NMAX
      II=NMAX*(M-1)+N
      . . .
      WRITE(14) UU,VV
 4900 CONTINUE
```

This file may be used for vector plotting.

File FT 15

57. This file contains the vertically integrated discharges DISCHX and DISCHY across the lower and right faces of each grid call for all the grid cells at the end of the run (ITIME=MAXTIM). This file is written on in subroutine POUT using the following statements:

```
      DO  31000   M=1, MMAX
      DO  31000   N=1, NMAX
      II = NMAX*(M-1)+N
      . . .
      WRITE(15)DISCHX(II),DISCHY(II)
31000 CONTINUE
```

File FT 20

58. This file contains some of the information needed for running a numerical sediment transport model subsequently, such as shoreline and breaker line positions, updated wave information, average values (averaged over ITAVG time-steps) of $\bar{\eta}$, U , V , and discharges across cell faces. It is written on in subroutines DEPTH, MOTN4, and POUT, respectively. The reader is referred to these subroutines for details.

PART VII: MODEL APPLICATION

Plane Beach: Longshore Currents

59. In order to demonstrate the use of the model for a simple situation, the case of monochromatic waves obliquely incident on a plane beach will be considered. This is the same case that was discussed in paragraphs 27-30 of PART IV except that the effect of setup, mixing, and advection are taken into account now during the course of the computation. The beach has a constant slope of 1:30. The wave characteristics in deep water are given by $T = 12$ sec, $H_o = 10$ ft, and $\theta_\infty = 20$ deg. For purposes of the present simulation, a uniform grid with $\Delta x = \Delta y = 60$ ft, NMAX = 6 , and MMAX = 50 is chosen. Also, let $c = 0.01$, $\gamma = 0.82$, $N_{LH} = 0.00783$, $\Delta t = 5.0$ sec, and NTIMEB = 15. Uniform flux boundary conditions are employed at the lateral boundaries and a radiation boundary condition at the offshore boundary. The simulation is run for 105 time-steps.

60. The CRAY JCL for running the program at BCS is shown in Figure 14. The user must supply his or her own user number (UN) and password (PW) and filename XXXLOG for dayfile. File WAVESRV has the results of a wave climate program for the case under consideration. File DEPBCH has the bathymetric information and file DATABCH most of the input data. No output files are saved.

61. The input data for the job from file DATABCH are shown in Figure 15. Note that the full print option MPR=-1 has been selected and NGAGE has been set to 20 with NFREQ=5 and JDELAY=0. As for eddy viscosity, IEDDY has been set to 1 (Longuet-Higgins formulation) so that both ANLH and XDIST have to be supplied. Note also that blank lines are used for input statements containing all zeros.

62. Figure 16 shows the "echo-print" of the input data by the program, Figure 17 the results of computation, and Figure 18 a sample printing of the results for selected gages. Note that the program prints the updated wave heights at the end of the run and the CPU time spent in the double-sweep computation.

Oregon Inlet

63. The next application to be considered is that of Oregon Inlet. This has been discussed at length in paragraphs 32-37 of PART IV. This is a

```
CDEXX,P02,T40,STCA1.
USER,UN,PW.
FETCH,DN=AA,GDN=WIFMSRC,UN=CEROD2,DT=C,DS=FF.
UPDATE,F,I=AA,P=0,C=0,N,L=0.
FETCH,DN=A,GDN=UPDL2RV,UN=CEROD2,DT=C,DS=FF.
UPDATE,F,P=$NPL,IN.
CFT,I=$CPL,L=0.
FETCH,DN=FT35,GDN=WAVESRV,UN=CCCD26,DS=CI.
FETCH,DN=FT36,GDN=DEPBCH,UN=CEROD2,DT=C,DS=FF.
FETCH,DN=FT95,GDN=DATABCH,UN=CEROD2,DT=C,DS=FF.
LDR.
REWIND,DN=FT07.
COPYD,I=FT07,O=$OUT.
REWIND,DN=FT08.
COPYD,I=FT08,O=$OUT.
EXIT,U.
COST,LO=F.
LOGFILE,L=LOG,FULL.
STORE,DN=LOG,GDN=XXXLOG,DT=C,DS=FF,UN=XXXXXX.
*WEOR
*READ A
*WEOR
   95
*WEOF
```

Figure 14. Job Control Language (JCL) for plane beach application

```
CURRENT MODEL - PLANE BEACH APPLICATION
 $WAVE PER=12.0,HTD=10.0,THETAD=20.0,DEPMAX=97.,GAMMA=0.82, $END
    6   50
    2 2000     1    -1   100
  5.0         60.         60.         32.2        .0001       0.0         5.0         1.0
0.4        -0.4         40.0        97.0        0.0        -97.0
  105    -1     0     0    20     5     0
  105
    4     4     4     4     4     4     4     4     4     4     4     4     4     4     4     4
    4    .4     4     4
    2     3     4     5     6     7     8     9    10    11    12    13    14    15    16    17
   18    47    48    49
  .03    .03




   1   1   1   1   1   1
   9   9   9   9   9   9


 299999999999999999999999999999999999999999999999999999999999999999999
999999999999999999999999999999
 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
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 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
 299999999999999999999999999999999999999999999999999999999999999999999
999999999999999999999999999999
 8 1 1  50   2   5   1
 9 0 2   1   2  49   0
 9 0 2   5   2  49   1
99
 0.0      0.0
    0
 $PAR RHO=1.99,EY=5.,RAD=1.,NTIMEB=15,ADV1=1.,FRC1=1.,CF=.01,
  ITAVG=0,AMLH=.00783, $END
 1
 -30.  30.  90. 150. 210. 270. 330. 390. 450. 510. 570. 630. 690. 750. 810. 870.
 930. 990.1050.1110.1170.1230.1290.1350.1410.1470.1530.1590.1650.1710.1770.1830.
1890.1950.2010.2070.2130.2190.2250.2310.2370.2430.2490.2550.2610.2670.2730.2790.
2850.2910.
 -30.  30.  90. 150. 210. 270. 330. 390. 450. 510. 570. 630. 690. 750. 810. 870.
 930. 990.1050.1110.1170.1230.1290.1350.1410.1470.1530.1590.1650.1710.1770.1830.
1890.1950.2010.2070.2130.2190.2250.2310.2370.2430.2490.2550.2610.2670.2730.2790.
2850.2910.
 -30.  30.  90. 150. 210. 270. 330. 390. 450. 510. 570. 630. 690. 750. 810. 870.
 930. 990.1050.1110.1170.1230.1290.1350.1410.1470.1530.1590.1650.1710.1770.1830.
1890.1950.2010.2070.2130.2190.2250.2310.2370.2430.2490.2550.2610.2670.2730.2790.
2850.2910.
 -30.  30.  90. 150. 210. 270. 330. 390. 450. 510. 570. 630. 690. 750. 810. 870.
 930. 990.1050.1110.1170.1230.1290.1350.1410.1470.1530.1590.1650.1710.1770.1830.
1890.1950.2010.2070.2130.2190.2250.2310.2370.2430.2490.2550.2610.2670.2730.2790.
2850.2910.
 -30.  30.  90. 150. 210. 270. 330. 390. 450. 510. 570. 630. 690. 750. 810. 870.
 930. 990.1050.1110.1170.1230.1290.1350.1410.1470.1530.1590.1650.1710.1770.1830.
1890.1950.2010.2070.2130.2190.2250.2310.2370.2430.2490.2550.2610.2670.2730.2790.
2850.2910.
 -30.  30.  90. 150. 210. 270. 330. 390. 450. 510. 570. 630. 690. 750. 810. 870.
 930. 990.1050.1110.1170.1230.1290.1350.1410.1470.1530.1590.1650.1710.1770.1830.
1890.1950.2010.2070.2130.2190.2250.2310.2370.2430.2490.2550.2610.2670.2730.2790.
2850.2910.
```

Figure 15. Input data for plane beach application

```
INPUT DATA--CARD GROUP 1A   NOTAP=    95

INPUT DATA--CARD GROUP 1B     CURRENT MODEL - PLANE BEACH APPLICATION

INPUT DATA--CARD GROUP 1C
&WAVE  PER = 12.,  HTO = 10.,  THETAL = 20.,  DEPMAX = 97.,  GAMMA = 0.82,  &END

INPUT DATA--CARD GROUP 2
    NMAX,MMAX
       6   50

INPUT DATA--CARD GROUP 3
    ITID,JTID,NTID,MPR,MSURF
       2 2000    1   -1  100

INPUT DATA--CARD GROUP 4
    TAU,DX,DY,G,EPSD,DCON1,DMPX,VIS, XLANJ,XSCOUR,SMAX,DMAXG,DCON2,ULIMIT
      5.0000        60.000        60.000        32.200        0.10000E-03  0.00000        5.0000        1.0000
      0.40000       -0.40000       40.000        97.000        0.00000       -97.000

INPUT DATA--CARD GROUP 5
    MAXTIM,INTAP,IDELAY,IXPAN,NGAGE,AFREQ,NLP
      105   -1     0        20    5     0

INPUT DATA--CARD GROUP 7
    NPRINT
      105    0    0         0    0    0    0    0    0    0    0    0    0    0    0

INPUT DATA--CARD GROUP 8
    SPECIAL GAGE LOCATIONS
      NPOT    4    4    4    4    4    4    4    4    4    4    4    4    4    4    4    4    4    4    4    4

      MPOT    2    3    4    5    6    7    8    9   10   11   12   13   14   15   16   17   18   47   48   49

 INPUT DATA--CARD GROUP 12
    FRICTION CODES XMAN
           0.030    0.030    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
           0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
    BARRIER HEIGHTS
           0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
           0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
    BARRIER CHEZYS
           0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
           0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
```

Figure 16. Echo print of input data for plane beach application (Sheet 1 of 8)

WAVE NUMBER AK
MULTIPLIED BY 10000.

I	J 1	2	3	4	5	6
1	0	0	0	0	0	0
2	924	924	924	924	924	924
3	535	535	535	535	535	535
4	416	416	416	416	416	416
5	352	352	352	352	352	352
6	312	312	312	312	312	312
7	283	283	283	283	283	283
8	261	261	261	261	261	261
9	243	243	243	243	243	243
10	229	229	229	229	229	229
11	218	218	218	218	218	218
12	208	208	208	208	208	208
13	199	199	199	199	199	199
14	191	191	191	191	191	191
15	185	185	185	185	165	185
16	179	179	179	179	179	179
17	173	173	173	173	173	173
18	169	169	169	169	169	169
19	164	164	164	164	164	164
20	160	160	160	160	160	160
21	156	156	156	156	156	156
22	153	153	153	153	153	153
23	150	150	150	150	150	150
24	147	147	147	147	147	147
25	144	144	144	144	144	144
26	142	142	142	142	142	142
27	139	139	139	139	139	139
28	137	137	137	137	137	137
29	135	135	135	135	135	135
30	133	133	133	133	133	133
31	131	131	131	131	131	131
32	129	129	129	129	129	129
33	128	128	128	128	128	128
34	126	126	126	126	126	126
35	125	125	125	125	125	125
36	123	123	123	123	123	123
37	122	122	122	122	122	122
38	121	121	121	121	121	121
39	119	119	119	119	119	119
40	118	118	118	118	118	118
41	117	117	117	117	117	117
42	116	116	116	116	116	116
43	115	115	115	115	115	115
44	114	114	114	114	114	114
45	113	113	113	113	113	113
46	112	112	112	112	112	112
47	111	111	111	111	111	111
48	110	110	110	110	110	110
49	109	109	109	[illegible]	109	109
50	109	109	109	109	109	109

Figure 16. (Sheet 2 of 8)

WAVE ANGLE DEG
MULTIPLIED BY 100.00

I J	1	2	3	4	5	6
1	0	0	0	0	0	0
2	216	216	216	216	216	216
3	327	327	327	327	327	327
4	411	411	411	411	411	411
5	481	481	481	481	481	481
6	541	541	541	541	541	541
7	595	595	595	595	595	595
8	644	644	644	644	644	644
9	690	690	690	690	690	690
10	732	732	732	732	732	732
11	771	771	771	771	771	771
12	808	808	808	808	808	808
13	843	843	843	843	843	843
14	877	877	877	877	877	877
15	909	909	909	909	909	909
16	939	939	939	939	939	939
17	968	968	968	968	968	968
18	996	996	996	996	996	996
19	1023	1023	1023	1023	1023	1023
20	1049	1049	1049	1049	1049	1049
21	1074	1074	1074	1074	1074	1074
22	1098	1098	1098	1098	1098	1098
23	1121	1121	1121	1121	1121	1121
24	1143	1143	1143	1143	1143	1143
25	1165	1165	1165	1165	1165	1165
26	1186	1186	1186	1186	1186	1186
27	1207	1207	1207	1207	1207	1207
28	1227	1227	1227	1227	1227	1227
29	1246	1246	1246	1246	1246	1246
30	1265	1265	1265	1265	1265	1265
31	1283	1283	1283	1283	1283	1283
32	1301	1301	1301	1301	1301	1301
33	1318	1318	1318	1318	1318	1318
34	1335	1335	1335	1335	1335	1335
35	1352	1352	1352	1352	1352	1352
36	1368	1368	1368	1368	1368	1368
37	1383	1383	1383	1383	1383	1383
38	1398	1398	1398	1398	1398	1398
39	1413	1413	1413	1413	1413	1413
40	1428	1428	1428	1428	1428	1428
41	1442	1442	1442	1442	1442	1442
42	1456	1456	1456	1456	1456	1456
43	1469	1469	1469	1469	1469	1469
44	1482	1482	1482	1482	1482	1482
45	1495	1495	1495	1495	1495	1495
46	1507	1507	1507	1507	1507	1507
47	1520	1520	1520	1520	1520	1520
48	1531	1531	1531	1531	1531	1531
49	1543	1543	1543	1543	1543	1543
50	1554	1554	1554	1554	1554	1554

Figure 16. (Sheet 3 of 8)

WAVE HEIGHT HT
MULTIPLIED BY 100.00

I J	1	2	3	4	5	6
1	0	0	0	0	0	0
2	82	82	82	82	82	82
3	246	246	246	246	246	246
4	410	410	410	410	410	410
5	574	574	574	574	574	574
6	738	738	738	738	738	738
7	902	902	902	902	902	902
8	1066	1066	1066	1066	1066	1066
9	1218	1218	1218	1218	1218	1218
10	1185	1185	1185	1185	1185	1185
11	1158	1158	1158	1158	1158	1158
12	1134	1134	1134	1134	1134	1134
13	1114	1114	1114	1114	1114	1114
14	1096	1096	1096	1096	1096	1096
15	1079	1079	1079	1079	1079	1079
16	1065	1065	1065	1065	1065	1065
17	1052	1052	1052	1052	1052	1052
18	1040	1040	1040	1040	1040	1040
19	1030	1030	1030	1030	1030	1030
20	1020	1020	1020	1020	1020	1020
21	1011	1011	1011	1011	1011	1011
22	1003	1003	1003	1003	1003	1003
23	995	995	995	995	995	995
24	989	989	989	989	989	989
25	982	982	982	982	982	982
26	976	976	976	976	976	976
27	971	971	971	971	971	971
28	966	966	966	966	966	966
29	961	961	961	961	961	961
30	957	957	957	957	957	957
31	953	953	953	953	953	953
32	949	949	949	949	949	949
33	946	946	946	946	946	946
34	943	943	943	943	943	943
35	940	940	940	940	940	940
36	937	937	937	937	937	937
37	934	934	934	934	934	934
38	932	932	932	932	932	932
39	930	930	930	930	930	930
40	928	928	928	928	928	928
41	926	926	926	926	926	926
42	924	924	924	924	924	924
43	923	923	923	923	923	923
44	921	921	921	921	921	921
45	920	920	920	920	920	920
46	919	919	919	919	919	919
47	918	918	918	918	918	918
48	917	917	917	917	917	917
49	916	916	916	916	916	916
50	915	915	915	915	915	915

Figure 16. (Sheet 4 of 8)

```
INPUT DATA--CARD GROUP 14
ISHORE2(N) MATRIX
  1   1   1   1   1   1

IBRK1(N) MATRIX
  9   9   9   9   9   [illegible]

ISHORE3(N) MATRIX
  0   0   0   0   0   0

IBRK2(N) MATRIX
  0   0   0   0   0   0
```

ADJ BED ELEV
MULTIPLIED BY 10.000

I J	1	2	3	4	5	6
1	10	10	10	10	10	10
2	-10	-10	-10	-10	-10	-10
3	-30	-30	-30	-30	-30	-30
4	-50	-50	-50	-50	-50	-50
5	-70	-70	-70	-70	-70	-70
6	-90	-90	-90	-90	-90	-90
7	-110	-110	-110	-110	-110	-110
8	-130	-130	-130	-130	-130	-130
9	-150	-150	-150	-150	-150	-150
10	-170	-170	-170	-170	-170	-170
11	-190	-190	-190	-190	-190	-190
12	-210	-210	-210	-210	-210	-210
13	-230	-230	-230	-230	-230	-230
14	-250	-250	-250	-250	-250	-250
15	-270	-270	-270	-270	-270	-270
16	-290	-290	-290	-290	-290	-290
17	-310	-310	-310	-310	-310	-310
18	-330	-330	-330	-330	-330	-330
19	-350	-350	-350	-350	-350	-350
20	-370	-370	-370	-370	-370	-370
21	-390	-390	-390	-390	-390	-390
22	-410	-410	-410	-410	-410	-410
23	-430	-430	-430	-430	-430	-430
24	-450	-450	-450	-450	-450	-450
25	-470	-470	-470	-470	-470	-470
26	-490	-490	-490	-490	-490	-490
27	-510	-510	-510	-510	-510	-510
28	-530	-530	-530	-530	-530	-530
29	-550	-550	-550	-550	-550	-550
30	-570	-570	-570	-570	-570	-570
31	-590	-590	-590	-590	-590	-590

Figure 16. (Sheet 5 of 8)

32	-610	-610	-610	-610	-610	-610
33	-630	-630	-630	-630	-630	-630
34	-650	-650	-650	-650	-650	-650
35	-670	-670	-670	-670	-670	-670
36	-690	-690	-690	-690	-690	-690
37	-710	-710	-710	-710	-710	-710
38	-730	-730	-730	-730	-730	-730
39	-750	-750	-750	-750	-750	-750
40	-770	-770	-770	-770	-770	-770
41	-790	-790	-790	-790	-790	-790
42	-810	-810	-810	-810	-810	-810
43	-830	-830	-830	-830	-830	-830
44	-850	-850	-850	-850	-850	-850
45	-870	-870	-870	-870	-870	-870
46	-890	-890	-890	-890	-890	-890
47	-910	-910	-910	-910	-910	-910
48	-930	-930	-930	-930	-930	-930
49	-950	-950	-950	-950	-950	-950
50	-970	-970	-970	-970	-970	-970

SPECIAL PRINTOUT OF CODED FRICTION ARRAY -- CARD GROUP 15

M N				5		
1	2	2	2	2	2	2
2	99	2	2	2	2	99
3	99	2	2	2	2	99
4	99	2	2	2	2	99
5	99	2	2	2	2	99
6	99	2	2	2	2	99
7	99	2	2	2	2	99
8	99	2	2	2	2	99
9	99	2	2	2	2	99
10	99	2	2	2	2	99
11	99	2	2	2	2	99
12	99	2	2	2	2	99
13	99	2	2	2	2	99
14	99	2	2	2	2	99
15	99	2	2	2	2	99
16	99	2	2	2	2	99
17	99	2	2	2	2	99
18	99	2	2	2	2	99
19	99	2	2	2	2	99
20	99	2	2	2	2	99
21	99	2	2	2	2	99
22	99	2	2	2	2	99
23	99	2	2	2	2	99
24	99	2	2	2	2	99
25	99	2	2	2	2	99
26	99	2	2	2	2	99
27	99	2	2	2	2	99
28	99	2	2	2	2	99
29	99	2	2	2	2	99
30	99	2	2	2	2	99

Figure 16. (Sheet 6 of 8)

31	99	2	2	2	2	99
32	99	2	2	2	2	99
33	99	2	2	2	2	99
34	99	2	2	2	2	99
35	99	2	2	2	2	99
36	99	2	2	2	2	99
37	99	2	2	2	2	99
38	99	2	2	2	2	99
39	99	2	2	2	2	99
40	99	2	2	2	2	99
41	99	2	2	2	2	99
42	99	2	2	2	2	99
43	99	2	2	2	2	99
44	99	2	2	2	2	99
45	99	2	2	2	2	99
46	99	2	2	2	2	99
47	99	2	2	2	2	99
48	99	2	2	2	2	99
49	99	2	2	2	2	99
50	99	2	2	2	2	99

NO. OF FLOOD CELLS 0

```
INPUT DATA--CARD GROUP 17
   ITYP,INDX,IDIR,I1,I2,I3,I4
    8 1 1  50   2   5   1
    9 0 2   1   2  49   0
    9 0 2   5   2  49   1
   99 0 0   0   0   0   0

INPUT DATA--CARD GROUP 20   BOUNDARY ELEVATIONS
      0.0000  0.0000

INPUT DATA--CARD GROUP 23   JDELAY=      0

INPUT DATA--CARD GROUP 32
&PAR  RHO = 1.99,  EV = 5.,  RAD = 1.,  NTIMEB = 15,  ADV1 = 1.,  FKC1 = 1.,  ANLH = 7.83E-3,  CF = 1.E-2,  ITAVG = [illegible],  &END
INPUT DATA CARD GROUP 33     IEDDY=  1
```

Figure 16. (Sheet 7 of 8)

DIST FROM BEACH

I J	1	2	3	4	5	6
1	-30	-30	-30	-30	-30	-30
2	30	30	30	30	30	30
3	90	90	90	90	90	90
4	150	150	150	150	150	150
5	210	210	210	210	210	210
6	270	270	270	270	270	270
7	330	330	330	330	330	330
8	390	390	390	390	390	390
9	450	450	450	450	450	450
10	510	510	510	510	510	510
11	570	570	570	570	570	570
12	630	630	630	630	630	630
13	690	690	690	690	690	690
14	750	750	750	750	750	750
15	810	810	810	810	810	810
16	870	870	870	870	870	870
17	930	930	930	930	930	930
18	990	990	990	990	990	990
19	1050	1050	1050	1050	1050	1050
20	1110	1110	1110	1110	1110	1110
21	1170	1170	1170	1170	1170	1170
22	1230	1230	1230	1230	1230	1230
23	1290	1290	1290	1290	1290	1290
24	1350	1350	1350	1350	1350	1350
25	1410	1410	1410	1410	1410	1410
26	1470	1470	1470	1470	1470	1470
27	1530	1530	1530	1530	1530	1530
28	1590	1590	1590	1590	1590	1590
29	1650	1650	1650	1650	1650	1650
30	1710	1710	1710	1710	1710	1710
31	1770	1770	1770	1770	1770	1770
32	1830	1830	1830	1830	1830	1830
33	1890	1890	1890	1890	1890	1890
34	1950	1950	1950	1950	1950	1950
35	2010	2010	2010	2010	2010	2010
36	2070	2070	2070	2070	2070	2070
37	2130	2130	2130	2130	2130	2130
38	2190	2190	2190	2190	2190	2190
39	2250	2250	2250	2250	2250	2250
40	2310	2310	2310	2310	2310	2310
41	2370	2370	2370	2370	2370	2370
42	2430	2430	2430	2430	2430	2430
43	2490	2490	2490	2490	2490	2490
44	2550	2550	2550	2550	2550	2550
45	2610	2610	2610	2610	2610	2610
46	2670	2670	2670	2670	2670	2670
47	2730	2730	2730	2730	2730	2730
48	2790	2790	2790	2790	2790	2790
49	2850	2850	2850	2850	2850	2850
50	2910	2910	2910	2910	2910	2910

Figure 16. (Sheet 8 of 8)

EDDY VISC EX

I J	1	2	3	4	5	6
1	0	0	0	0	0	0
2	1	1	1	1	1	1
3	7	7	7	7	7	7
4	15	15	15	15	15	15
5	25	25	25	25	25	25
6	36	36	36	36	36	36
7	49	49	49	49	49	49
8	62	62	62	62	62	62
9	77	77	77	77	77	77
10	77	77	77	77	77	77
11	77	77	77	77	77	77
12	77	77	77	77	77	77
13	77	77	77	77	77	77
14	77	77	77	77	77	77
15	77	77	77	77	77	77
16	77	77	77	77	77	77
17	77	77	77	77	77	77
18	77	77	77	77	77	77
19	77	77	77	77	77	77
20	77	77	77	77	77	77
21	77	77	77	77	77	77
22	77	77	77	77	77	77
23	77	77	77	77	77	77
24	77	77	77	77	77	77
25	77	77	77	77	77	77
26	77	77	77	77	77	77
27	77	77	77	77	77	77
28	77	77	77	77	77	77
29	77	77	77	77	77	77
30	77	77	77	77	77	77
31	77	77	77	77	77	77
32	77	77	77	77	77	77
33	77	77	77	77	77	77
34	77	77	77	77	77	77
35	77	77	77	77	77	77
36	77	77	77	77	77	77
37	77	77	77	77	77	77
38	77	77	77	77	77	77
39	77	77	77	77	77	77
40	77	77	77	77	77	77
41	77	77	77	77	77	77
42	77	77	77	77	77	77
43	77	77	77	77	77	77
44	77	77	77	77	77	77
45	77	77	77	77	77	77
46	77	77	77	77	77	77
47	77	77	77	77	77	77
48	77	77	77	77	77	77
49	77	77	77	77	77	77
50	77	77	77	77	77	77

Figure 17. Results of computation for plane beach (Sheet 1 of 11)

ICF FLAG ARRAY

M	N	1	2	3	4	5	6
1		5050	5050	5050	5050	5050	5050
2		7050	6062	6262	6262	6090	1010
3		7050	6163	6363	6363	6190	1010
4		7090	6163	6363	6363	6190	1010
5		7090	6163	6363	6363	6190	1010
6		7090	6163	6363	6363	6190	1010
7		7090	6163	6363	6363	6190	1010
8		7090	6163	6363	6363	6190	1010
9		7050	6163	6363	6363	6190	1010
10		7050	6163	6363	6363	6190	1010
11		7050	6163	6363	6363	6190	1010
12		7090	6163	6363	6363	6190	1010
13		7090	6163	6363	6363	6190	1010
14		7090	6163	6363	6363	6190	1010
15		7050	6163	6363	6363	6190	1010
16		7090	6163	6363	6363	6190	1010
17		7050	6163	6363	6363	6190	1010
18		7050	6163	6363	6363	6190	1010
19		7090	6163	6363	6363	6190	1010
20		7090	6163	6363	6363	6190	1010
21		7050	6163	6363	6363	6190	1010
22		7050	6163	6363	6363	6190	1010
23		7090	6163	6363	6363	6190	1010
24		7050	6163	6363	6363	6190	1010
25		7090	6163	6363	6363	6190	1010
26		7090	6163	6363	6363	6190	1010
27		7090	6163	6363	6363	6190	1010
28		7050	6163	6363	6363	6190	1010
29		7050	6163	6363	6363	6190	1010
30		7050	6163	6363	6363	6190	1010
31		7050	6163	6363	6363	6190	1010
32		7050	6163	6363	6363	6190	1010
33		7050	6163	6363	6363	6190	1010
34		7050	6163	6363	6363	6190	1010
35		7090	6163	6363	6363	6190	1010
36		7050	6163	6363	6363	6190	1010
37		7050	6163	6363	6363	6190	1010
38		7050	6163	6363	6363	6190	1010
39		7050	6163	6363	6363	6190	1010
40		7090	6163	6363	6363	6190	1010
41		7050	6163	6363	6363	6190	1010
42		7050	6163	6363	6363	6190	1010
43		7050	6163	6363	6363	6190	1010
44		7090	6163	6363	6363	6190	1010
45		7090	6163	6363	6363	6190	1010
46		7090	6163	6363	6363	6190	1010
47		7050	6163	6363	6363	6190	1010
48		7050	6163	6363	6363	6190	1010
49		7090	6062	6262	6262	6090	1010
50		1010	8171	8171	8171	8171	1010

Figure 17. (Sheet 2 of 11)

TIDAL AND DISCHARGE BOUNDARY VECTORS---TRANSMISSION BOUNDARY VECTOR

1	1002050	20001002	0
2	1003050	20001003	0
3	1004050	20001004	0
4	1005050	20001005	0
5		20001006	0
6		20001007	0
7		20001008	0
8		20001009	0
9		20001010	0
10		20001011	0
11		20001012	0
12		20001013	0
13		20001014	0
14		20001015	0
15		20001016	0
16		20001017	0
17		20001018	0
18		20001019	0
19		20001020	0
20		20001021	0
21		20001022	0
22		20001023	0
23		20001024	0
24		20001025	0
25		20001026	0
26		20001027	0
27		20001028	0
28		20001029	0
29		20001030	0
30		20001031	0
31		20001032	0
32		20001033	0
33		20001034	0
34		20001035	0
35		20001036	0
36		20001037	0
37		20001038	0
38		20001039	0
39		20001040	0
40		20001041	0
41		20001042	0
42		20001043	0
43		20001044	0
44		20001045	0
45		20001046	0
46		20001047	0
47		20001048	0
48		20001049	0
49		20005002	0
50		20005003	0
51		20005004	0
52		20005005	0
53		20005006	0
54		20005007	0
55		20005008	0
56		20005009	0
57		20005010	0
58		20005011	0
59		20005012	0

Figure 17. (Sheet 3 of 11)

```
              60              20005013          0
              61              20005014          0
              62              20005015          0
              63              20005016          0
              64              20005017          0
              65              20005018          0
              66              20005019          0
              67              20005020          0
              68              20005021          0
              69              20005022          0
              70              20005023          0
              71              20005024          0
              72              20005025          0
              73              20005026          0
              74              20005027          0
              75              20005028          0
              76              20005029          0
              77              20005030          0
              76              20005031          0
              79              20005032          0
              80              20005033          0
              81              20005034          0
              82              20005035          0
              83              20005036          0
              84              20005037          0
              85              20005038          0
              86              20005039          0
              87              20005040          0
              88              20005041          0
              89              20005042          0
              90              20005043          0
              91              20005044          0
              92              20005045          0
              93              20005046          0
              94              20005047          0
              95              20005048          0
              96              20005049          0
BNDRY INPUTS--SURFE AND DCHRGE ARRAYS--LINEAR INTERPOLATION HAS BEEN USED

  T     I       1
    1         0.000
  101         0.000
  201         0.000
  301         0.000
  401         0.000
  501         0.000
  601         0.000
  701         0.000
  801         0.000
  901         0.000
 1001         0.000
 1101         0.000
 1201         0.000
 1301         0.000
 1401         0.000
 1501         0.000
 1601         0.000
 1701         0.000
 1801         0.000
 1901         0.000

*****END PRINTOUT OF INPUT DATA*****
```

Figure 17. (Sheet 4 of 11)

ORBITAL VEL UORB
MULTIPLIED BY 100.00

I J	1	2	3	4	5	6
1	0	0	0	0	0	0
2	148	148	148	148	148	148
3	254	254	254	254	254	254
4	326	326	326	326	326	326
5	384	384	384	384	384	384
6	433	433	433	433	433	433
7	476	476	476	476	476	476
8	514	514	514	514	514	514
9	544	544	544	544	544	544
10	494	494	494	494	494	494
11	454	454	454	454	454	454
12	420	420	420	420	420	420
13	392	392	392	392	392	392
14	368	368	368	368	368	368
15	346	346	346	346	346	346
16	328	328	328	328	328	328
17	311	311	311	311	311	311
18	296	296	296	296	296	296
19	283	283	283	283	283	283
20	271	271	271	271	271	271
21	260	260	260	260	260	260
22	250	250	250	250	250	250
23	240	240	240	240	240	240
24	232	232	232	232	232	232
25	224	224	224	224	224	224
26	217	217	217	217	217	217
27	210	210	210	210	210	210
28	203	203	203	203	203	203
29	197	197	197	197	197	197
30	191	191	191	191	191	191
31	186	186	186	186	186	186
32	181	181	181	181	181	181
33	176	176	176	176	176	176
34	172	172	172	172	172	172
35	167	167	167	167	167	167
36	163	163	163	163	163	163
37	159	159	159	159	159	159
38	156	156	156	156	156	156
39	152	152	152	152	152	152
40	145	149	149	149	149	149
41	145	145	145	145	145	145
42	142	142	142	142	142	142
43	139	139	139	139	139	139
44	136	136	136	136	136	136
45	134	134	134	134	134	134
46	131	131	131	131	131	131
47	128	128	128	128	128	128
48	126	126	126	126	126	126
49	123	123	123	123	123	123
50	121	121	121	121	121	121

Figure 17. (Sheet 5 of 11)

WAVE HEIGHT HT
MULTIPLIED BY 100.00

I J	1	2	3	4	5	6
1	0	0	0	0	0	0
2	228	228	228	228	228	228
3	355	355	355	355	355	355
4	484	484	484	484	484	484
5	613	613	613	613	613	613
6	742	742	742	742	742	742
7	870	870	870	870	870	870
8	997	997	997	997	997	997
9	1124	1124	1124	1124	1124	1124
10	1185	1185	1185	1185	1185	1185
11	1158	1158	1158	1158	1158	1158
12	1134	1134	1134	1134	1134	1134
13	1114	1114	1114	1114	1114	1114
14	1096	1096	1096	1096	1096	1096
15	1079	1079	1079	1079	1079	1079
16	1065	1065	1065	1065	1065	1065
17	1052	1052	1052	1052	1052	1052
18	1040	1040	1040	1040	1040	1040
19	1030	1030	1030	1030	1030	1030
20	1020	1020	1020	1020	1020	1020
21	1011	1011	1011	1011	1011	1011
22	1003	1003	1003	1003	1003	1003
23	995	995	995	995	995	995
24	989	989	989	989	989	989
25	982	982	982	982	982	982
26	976	976	976	976	976	976
27	971	971	971	971	971	971
28	966	966	966	966	966	966
29	961	961	961	961	961	961
30	957	957	957	957	957	957
31	953	953	953	953	953	953
32	949	949	949	949	949	949
33	946	946	946	946	946	946
34	943	943	943	943	943	943
35	940	940	940	940	940	940
36	937	937	937	937	937	937
37	934	934	934	934	934	934
38	932	932	932	932	932	932
39	930	930	930	930	930	930
40	928	928	928	928	928	928
41	926	926	926	926	926	926
42	924	924	924	924	924	924
43	923	923	923	923	923	923
44	921	921	921	921	921	921
45	920	920	920	920	920	920
46	919	919	919	919	919	919
47	918	918	918	918	918	918
48	917	917	917	917	917	917
49	916	916	916	916	916	916
50	915	915	915	915	915	915

ELEVATION AT T = 0.1458 HRS ITIME = 105

Figure 17. (Sheet 6 of 11)

SURFACE ELEV
MULTIPLIED BY 100.00

I J	1	2	3	4	5	6
1	100	100	100	100	100	100
2	183	183	183	183	183	183
3	141	141	141	141	141	141
4	103	103	103	103	103	103
5	66	66	66	66	66	66
6	29	29	29	29	29	29
7	-6	-6	-6	-6	-6	-6
8	-41	-41	-41	-41	-41	-41
9	-75	-75	-75	-75	-75	-75
10	-90	-90	-90	-90	-90	-90
11	-82	-82	-82	-82	-82	-82
12	-76	-76	-76	-76	-76	-76
13	-72	-72	-72	-72	-72	-72
14	-68	-68	-68	-68	-68	-68
15	-65	-65	-65	-65	-65	-65
16	-63	-63	-63	-63	-63	-63
17	-61	-61	-61	-61	-61	-61
18	-59	-59	-59	-59	-59	-59
19	-57	-57	-57	-57	-57	-57
20	-56	-56	-56	-56	-56	-56
21	-55	-55	-55	-55	-55	-55
22	-54	-54	-54	-54	-54	-54
23	-53	-53	-53	-53	-53	-53
24	-52	-52	-52	-52	-52	-52
25	-51	-51	-51	-51	-51	-51
26	-51	-51	-51	-51	-51	-51
27	-50	-50	-50	-50	-50	-50
28	-50	-50	-50	-50	-50	-50
29	-49	-49	-49	-49	-49	-49
30	-49	-49	-49	-49	-49	-49
31	-48	-48	-48	-48	-48	-48
32	-48	-48	-48	-48	-48	-48
33	-48	-48	-48	-48	-48	-48
34	-47	-47	-47	-47	-47	-47
35	-47	-47	-47	-47	-47	-47
36	-47	-47	-47	-47	-47	-47
37	-46	-46	-46	-46	-46	-46
38	-46	-46	-46	-46	-46	-46
39	-46	-46	-46	-46	-46	-46
40	-46	-46	-46	-46	-46	-46
41	-46	-46	-46	-46	-46	-46
42	-45	-45	-45	-45	-45	-45
43	-45	-45	-45	-45	-45	-45
44	-45	-45	-45	-45	-45	-45
45	-45	-45	-45	-45	-45	-45
46	-45	-45	-45	-45	-45	-45
47	-45	-45	-45	-45	-45	-45
48	-45	-45	-45	-45	-45	-45
49	-44	-44	-44	-44	-44	-44
50	0	-44	-44	-44	-44	0

Figure 17. (Sheet 7 of 11)

VELOCITY V
MULTIPLIED BY 100.00

I J	1	2	3	4	5	6
1	0	0	0	0	0	0
2	-78	-78	-78	-78	-78	0
3	-142	-142	-142	-142	-142	0
4	-205	-205	-205	-205	-205	0
5	-254	-254	-254	-254	-254	0
6	-285	-285	-285	-285	-285	0
7	-294	-294	-294	-294	-294	0
8	-277	-277	-277	-277	-277	0
9	-232	-232	-232	-232	-232	0
10	-168	-168	-168	-168	-168	0
11	-111	-111	-111	-111	-111	0
12	-73	-73	-73	-73	-73	0
13	-47	-47	-47	-47	-47	0
14	-29	-29	-29	-29	-29	0
15	-18	-18	-18	-18	-18	0
16	-10	-10	-10	-10	-10	0
17	-6	-6	-6	-6	-6	0
18	-3	-3	-3	-3	-3	0
19	-1	-1	-1	-1	-1	0
20	0	0	0	0	0	0
21	0	0	0	0	0	0
22	1	1	1	1	1	0
23	1	1	1	1	1	0
24	1	1	1	1	1	0
25	1	1	1	1	1	0
26	1	1	1	1	1	0
27	1	1	1	1	1	0
28	1	1	1	1	1	0
29	1	1	1	1	1	0
30	1	1	1	1	1	0
31	1	1	1	1	1	0
32	1	1	1	1	1	0
33	1	1	1	1	1	0
34	1	1	1	1	1	0
35	1	1	1	0	0	0
36	0	0	0	0	0	0
37	0	0	0	0	0	0
38	0	0	0	0	0	0
39	0	0	0	0	0	0
40	0	0	0	0	0	0
41	0	0	0	0	0	0
42	0	0	0	0	0	0
43	0	0	0	0	0	0
44	0	0	0	0	0	0
45	0	0	0	0	0	0
46	0	0	0	0	0	0
47	0	0	0	0	0	0
48	0	0	0	0	0	0
49	0	0	0	0	0	0
50	0	0	0	0	0	0

Figure 17. (Sheet 8 of 11)

VELOCITY U
MULTIPLIED BY 100.00

I J	1	2	3	4	5	6
1	0	0	0	0	0	0
2	0	2	2	2	2	0
3	0	2	2	2	2	0
4	0	2	2	2	2	0
5	0	2	2	2	2	0
6	0	2	2	2	2	0
7	0	2	2	2	2	0
8	0	3	3	3	3	0
9	0	2	2	2	2	0
10	0	3	3	3	3	0
11	0	3	3	3	3	0
12	0	3	3	3	3	0
13	0	3	3	3	3	0
14	0	3	3	3	3	0
15	0	3	3	3	3	0
16	0	3	3	3	3	0
17	0	3	3	3	3	0
18	0	3	3	3	3	0
19	0	3	3	3	3	0
20	0	3	3	3	3	0
21	0	3	3	3	3	0
22	0	3	3	3	3	0
23	0	3	3	3	3	0
24	0	3	3	3	3	0
25	0	3	3	3	3	0
26	0	3	3	3	3	0
27	0	3	3	3	3	0
28	0	3	3	3	3	0
29	0	3	3	3	3	0
30	0	3	3	3	3	0
31	0	3	3	3	3	0
32	0	3	3	3	3	0
33	0	3	3	3	3	0
34	0	3	3	3	3	0
35	0	3	3	3	3	0
36	0	3	3	3	3	0
37	0	3	3	3	3	0
38	0	3	3	3	3	0
39	0	3	3	3	3	0
40	0	3	3	3	3	0
41	0	3	3	3	3	0
42	0	3	3	3	3	0
43	0	3	3	3	3	0
44	0	3	3	3	3	0
45	0	3	3	3	3	0
46	0	3	3	3	3	0
47	0	3	3	3	3	0
48	0	3	3	3	3	0
49	0	3	4	4	3	0
50	0	0	0	0	0	0

Figure 17. (Sheet 9 of 11)

DISCHARGE Y DIR
MULTIPLIED BY 0.10000E-01

I J	1	2	3	4	5	6
1	0	0	0	0	0	0
2	-1	-1	-1	-1	-1	0
3	-4	-4	-4	-4	-4	0
4	-7	-7	-7	-7	-7	0
5	-12	-12	-12	-12	-12	0
6	-16	-16	-16	-16	-16	0
7	-19	-19	-19	-19	-19	0
8	-21	-21	-21	-21	-21	0
9	-20	-20	-20	-20	-20	0
10	-16	-16	-16	-16	-16	0
11	-12	-12	-12	-12	-12	0
12	-9	-9	-9	-9	-9	0
13	-6	-6	-6	-6	-6	0
14	-4	-4	-4	-4	-4	0
15	-3	-3	-3	-3	-3	0
16	-2	-2	-2	-2	-2	0
17	-1	-1	-1	-1	-1	0
18	-1	-1	-1	-1	-1	0
19	0	0	0	0	0	0
20	0	0	0	0	0	0
21	0	0	0	0	0	0
22	0	0	0	0	0	0
23	0	0	0	0	0	0
24	0	0	0	0	0	0
25	0	0	0	0	0	0
26	0	0	0	0	0	0
27	0	0	0	0	0	0
28	0	0	0	0	0	0
29	0	0	0	0	0	0
30	0	0	0	0	0	0
31	0	0	0	0	0	0
32	0	0	0	0	0	0
33	0	0	0	0	0	0
34	0	0	0	0	0	0
35	0	0	0	0	0	0
36	0	0	0	0	0	0
37	0	0	0	0	0	0
38	0	0	0	0	0	0
39	0	0	0	0	0	0
40	0	0	0	0	0	0
41	0	0	0	0	0	0
42	0	0	0	0	0	0
43	0	0	0	0	0	0
44	0	0	0	0	0	0
45	0	0	0	0	0	0
46	0	0	0	0	0	0
47	0	0	0	0	0	0
48	0	0	0	0	0	0
49	0	0	0	0	0	0
50	0	0	0	0	0	0

Figure 17. (Sheet 10 of 11)

DISCHARGE X DIR
MULTIPLIED BY 0.10000E-01

I J	1	2	3	4	5	6
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	0	0	0	0	0
7	0	0	0	0	0	0
8	0	0	0	0	0	0
9	0	0	0	0	0	0
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0
13	0	0	0	0	0	0
14	0	0	0	0	0	0
15	0	0	0	0	0	0
16	0	0	0	0	0	0
17	0	0	0	0	0	0
18	0	1	1	1	1	0
19	0	1	1	1	1	0
20	0	1	1	1	1	0
21	0	1	1	1	1	0
22	0	1	1	1	1	0
23	0	1	1	1	1	0
24	0	1	1	1	1	0
25	0	1	1	1	1	0
26	0	1	1	1	1	0
27	0	1	1	1	1	0
28	0	1	1	1	1	0
29	0	1	1	1	1	0
30	0	1	1	1	1	0
31	0	1	1	1	1	0
32	0	1	1	1	1	0
33	0	1	1	1	1	0
34	0	1	1	1	1	0
35	0	1	1	1	1	0
36	0	1	1	1	1	0
37	0	1	1	1	1	0
38	0	1	1	1	1	0
39	0	1	1	1	1	0
40	0	1	1	1	1	0
41	0	1	1	1	1	0
42	0	1	1	1	1	0
43	0	1	2	2	1	0
44	0	1	2	2	1	0
45	0	2	2	2	2	0
46	0	2	2	2	2	0
47	0	2	2	2	2	0
48	0	2	2	2	2	0
49	0	2	2	2	2	0
50	0	0	0	0	0	0

TIMES FOR START,STOP, AND EXECUTION -- 5.186 7.195 2.009

Figure 17. (Sheet 11 of 11)

TIME	GAGE NO. / QUANTITY	1 (4, 2)	2 (4, 3)	3 (4, 4)	4 (4, 5)	5 (4, 6)	6 (4, 7)	7 (4, 8)	8 (4, 9)	9 (4, 10)	10 (4, 11)
0	SURF ELV	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	UVEL F/S	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	VVEL F/S	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	GRD ELEV	-1.00	-3.00	-5.00	-7.00	-9.00	-11.00	-13.00	-15.00	-17.00	-19.00
	VCTR F/S	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
5	SURF ELV	0.4263	0.3865	0.2934	0.1857	0.0693	-0.0485	-0.1641	-0.2810	-0.2754	-0.2192
	UVEL F/S	-0.5159	-1.0000	-0.9141	-0.7975	-0.6742	-0.5567	-0.4489	-0.3447	-0.2555	-0.1859
	VVEL F/S	-0.0706	-0.0672	-0.0832	-0.6951	-0.1045	-0.1116	-0.1109	-0.0693	-0.0184	-0.0009
	GRD ELEV	-1.00	-3.00	-5.00	-7.00	-9.00	-11.00	-13.00	-15.00	-17.00	-19.00
	VCTR F/S	0.5208	1.0022	0.9178	0.8036	0.6823	0.5678	0.4624	0.3515	0.2561	0.1859
10	SURF ELV	1.6435	1.2335	0.8700	0.5587	0.2766	0.0043	-0.2628	-0.5111	-0.5759	-0.5044
	UVEL F/S	-0.3025	-0.7349	-0.9010	-0.5305	-0.8933	-0.8174	-0.7253	-0.6331	-0.5425	-0.4574
	VVEL F/S	-0.1810	-0.2063	-0.2587	-0.2943	-0.3226	-0.3394	-0.3228	-0.2163	-0.0785	-0.0108
	GRD ELEV	-1.00	-3.00	-5.00	-7.00	-9.00	-11.00	-13.00	-15.00	-17.00	-19.00
	VCTR F/S	0.3525	0.7633	0.9374	0.5759	0.9498	0.8851	0.7939	0.6691	0.5481	0.4575
15	SURF ELV	2.3364	1.8388	1.4556	1.0908	0.7119	0.3163	-0.0710	-0.4513	-0.5804	-0.5253
	UVEL F/S	-0.2410	-0.4991	-0.4951	-0.4657	-0.4517	-0.4405	-0.4333	-0.4153	-0.3896	-0.3663
	VVEL F/S	-0.3387	-0.4074	-0.5082	-0.5796	-0.6346	-0.6590	-0.6128	-0.4221	-0.1739	-0.0354
	GRD ELEV	-1.00	-3.00	-5.00	-7.00	-9.00	-11.00	-13.00	-15.00	-17.00	-19.00
	VCTR F/S	0.4157	0.6443	0.7095	0.7435	0.7789	0.7926	0.7505	0.5922	0.4266	0.3685
20	SURF ELV	2.4966	2.0132	1.6152	1.2119	0.8076	0.4233	0.0553	-0.3006	-0.3732	-0.3087
	UVEL F/S	0.0839	0.2005	0.2226	0.1754	0.1030	0.0442	0.0143	0.0052	0.0012	-0.0040
	VVEL F/S	-0.4695	-0.5836	-0.7347	-0.8470	-0.9299	-0.9617	-0.8907	-0.6242	-0.2883	-0.0883
	GRD ELEV	-1.00	-3.00	-5.00	-7.00	-9.00	-11.00	-13.00	-15.00	-17.00	-19.00
	VCTR F/S	0.4774	0.6171	0.7677	0.8650	0.9356	0.9627	0.8908	0.6242	0.2883	0.0844
25	SURF ELV	2.2301	1.8163	1.4504	1.0798	0.7318	0.3979	0.0759	-0.2429	-0.2869	-0.2215
	UVEL F/S	0.0402	0.0871	0.1063	0.1269	0.1482	0.1814	0.2113	0.2267	0.2227	0.1992
	VVEL F/S	-0.5634	-0.7263	-0.9266	-1.0825	-1.1959	-1.2406	-1.1534	-0.8319	-0.4266	-0.1590
	GRD ELEV	-1.00	-3.00	-5.00	-7.00	-9.00	-11.00	-13.00	-15.00	-17.00	-19.00
	VCTR F/S	0.5698	0.7315	0.9326	1.0899	1.2050	1.2538	1.1725	0.8622	0.4812	0.2548
30	SURF ELV	2.1977	1.7476	1.3670	0.5956	0.6348	0.2874	-0.0461	-0.3913	-0.4726	-0.4015
	UVEL F/S	0.0331	0.0529	0.0348	0.0261	0.0308	0.0426	0.0499	0.0537	0.0503	0.0480
	VVEL F/S	-0.6330	-0.8463	-1.0933	-1.2874	-1.4264	-1.4766	-1.3669	-1.0144	-0.5621	-0.2410
	GRD ELEV	-1.00	-3.00	-5.00	-7.00	-9.00	-11.00	-13.00	-15.00	-17.00	-19.00
	VCTR F/S	0.6339	0.8479	1.0939	1.2876	1.4267	1.4773	1.3698	1.0158	0.5643	0.2457
35	SURF ELV	2.1669	1.7026	1.3305	0.9643	0.6007	0.2506	-0.1019	-0.4452	-0.5422	-0.4693
	UVEL F/S	-0.0015	0.0025	0.0200	0.0414	0.0528	0.0530	0.0506	0.0468	0.0419	0.0435
	VVEL F/S	-0.6810	-0.9501	-1.2428	-1.4736	-1.6346	-1.6859	-1.5586	-1.1767	-0.6861	-0.3204
	GRD ELEV	-1.00	-3.00	-5.00	-7.00	-9.00	-11.00	-13.00	-15.00	-17.00	-19.00
	VCTR F/S	0.6810	0.9501	1.2430	1.4742	1.6355	1.6667	1.5594	1.1776	0.6874	0.3233
40	SURF ELV	2.1126	1.6597	1.2924	0.5237	0.5610	0.1959	-0.1520	-0.4988	-0.5952	-0.5142
	UVEL F/S	0.0183	0.0442	0.0653	0.0789	0.0765	0.0669	0.0558	0.0510	0.0518	0.0590
	VVEL F/S	-0.7131	-1.0295	-1.3647	-1.6293	-1.8097	-1.8629	-1.7233	-1.3231	-0.8029	-0.4000
	GRD ELEV	-1.00	-3.00	-5.00	-7.00	-9.00	-11.00	-13.00	-15.00	-17.00	-19.00
	VCTR F/S	0.7133	1.0304	1.3662	1.6312	1.8113	1.8641	1.7242	1.3241	0.6046	0.4044
45	SURF ELV	2.0508	1.6104	1.2348	0.8710	0.5047	0.1563	-0.1869	-0.5248	-0.6240	-0.5426
	UVEL F/S	0.0175	0.0370	0.0398	0.0391	0.0425	0.0435	0.0444	0.0470	0.0474	0.0509
	VVEL F/S	-0.7359	-1.0977	-1.4726	-1.7689	-1.9677	-2.0236	-1.8753	-1.4556	-0.9140	-0.4792

Figure 18. Sample results for selected gages for plane beach computation

more complicated situation. A variable grid is employed, with NMAX=77 and MMAX=54, so as to have a greater resolution near the inlet and the surf zone. The JCL for this case is shown in Figure 19. In addition to files FT 35, 36, and 95, file FT 39 containing the grid expansion coefficients is needed. In this case, output files FT 11, 13, 14, 15, and 20 are being saved at the end of the run for later use.

64. Part of the input data from file DATAW3L is shown in Figure 20. Note that MPR is set to -1 for full printout, $\Delta\alpha_1 = \Delta\alpha_2 = 100$ ft and $\Delta t = 18$ sec. The simulation is run for 67 time-steps. Twenty special gages are used with NFREQ=2. A printout of results is desired at ITIME=67. There are two surf zones over a part of the grid. JDELAY is set to 15 to delay printing of gage information. It is desired to build up the radiation stress terms over 15 time-steps (NTIMEB=15). γ is set to 0.754. Averaging of results over the last 10 time-steps is required (ITAVG=10). Jonsson-type eddy viscosity formulation is desired so IEDDY is set to 2.

65. Figure 21 shows the coded friction array and the flags for this application. A sampling of the averaged results for $\bar{\eta}$, U, and V at the end is also shown.

Cost of Computation

66. In general, the cost of running the model depends on the number of grid points used, the number of time-steps of simulation run, amount of input and output, the job priority, the computer, and the computer vendor used. The following total cost information was for running the model at standard priority on the CRAY computer of BCS. For the plane beach application, described in paragraphs 59-62, involving 300 grid points and 105 time-steps, the total cost was approximately \$7. For the Oregon Inlet application, described in paragraphs 63-65, involving 4,158 grid points and 67 time-steps, the total cost was approximately \$23. Therefore the computation costs for the model may be considered modest.

```
CDEXX,P02,T40,STCA1.
USER,UN,PW.
FETCH,DN=AA,GDN=WIFMSRC,UN=CER0D2,DT=C,DS=FF.
UPDATE,F,I=AA,P=0,C=0,N,L=0.
FETCH,DN=A,GDN=UPDL2RV,UN=CER0D2,DT=C,DS=FF.
UPDATE,F,P=$NPL,IN.
CFT,I=$CPL,L=0.
FETCH,DN=FT35,GDN=AWED3M,UN=CCC026,DS=CI.
FETCH,DN=FT36,GDN=ORDPRV1,UN=CER0D2,DT=C,DS=FF.
FETCH,DN=FT39,GDN=EXPCFRV,UN=CER0D2,DT=C,DS=FF.
FETCH,DN=FT95,GDN=DATAW3L,UN=CER0D2,DT=C,DS=FF.
LDR.
REWIND,DN=FT07.
COPYD,I=FT07,O=$OUT.
REWIND,DN=FT08.
COPYD,I=FT08,O=$OUT.
REWIND,DN=FT11.
STORE,DN=FT11,GDN=OREGAGE,PAM=R,DS=CI,NEW,NA.
REWIND,DN=FT13.
STORE,DN=FT13,GDN=ORESURF,PAM=R,DS=CI,NEW,NA.
REWIND,DN=FT14.
STORE,DN=FT14,GDN=OREVEL,PAM=R,DS=CI,NEW,NA.
REWIND,DN=FT15.
STORE,DN=FT15,GDN=OREDIS,PAM=R,DS=CI,NEW,NA.
REWIND,DN=FT20.
STORE,DN=FT20,GDN=ORESEDI,PAM=R,DS=CI,NEW,NA.
EXIT,U.
COST,LO=F.
LOGFILE,L=LOG,FULL.
STORE,DN=LOG,GDN=XXXLOG,DT=C,DS=FF,UN=XXXXXX.
*WEOR
*READ A
*WEOR
   95
*WEOF
```

Figure 19. Job Control Language (JCL) for Oregon Inlet, North Carolina, application

```
CURRENT MODEL - OREGON INLET APPLICATION
 $WAVE PER=8.0,HTO=11.39,THETAD=51.1,DEPMAX=61.,GAMMA=0.754, $END
   77   54
    2 2000    1    -1   100
 18.0         100.         100.        32.2          .0001        0.0         5.0         1.0
0.4        -0.4        40.0        63.0        0.0        -63.0
   67   -1     0     1    20     2     0
   67
    4     4     4    32    36    37    37    37    38    38    40    73    73    73    51    52
   53    52    52    52
   23    25    27     2    14     2    11    16    10    19    26    12    14    16    35    35
   35    34    36    37
 .03     .03




  22   22   22   22   22   22   22   22   22   22   22   22   22   22   22   22   22   22   22   22
  22   21   21   21   21   21   21   21   21   21   21   20   19   16   13   12   15   17   26   25
  24   21   13   14   16   21    9   10   10   11   11   11   11   11   11   11   10   10   10   10
  11   10   11   11   11   11   11   11   11   11   11   11   11   11   11   11   11
  35   35   35   35   35   35   35   35   35   35   35   35   35   35   35   34   35   36   37   35
  33   35   35   32   34   37   35   36   36   41   41   40   41   41   40   40   41   42   42   42
  43   43   42   43   43   43   12   16   18   22   31   44   45   43   43   35   33   27   20   22
  21   24   22   22   23   23   24   24   23   24   24   24   24   24   24   24   24


                                26   31   37   38   38



                                44   45   46   47   45
999999999999999999999999 2 2 2 2 2 2 2 2 2 2999999999999999999999999999
99999999999999999999999999999999999999
99 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
99 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
99 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
99 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
 2 2 2 2 2 2 2 2 2 2 2999999999999999999999999999999999999999999999999
99999999999999999999999999999999999999
 8 1 1   54    2   76     1
 9 0 2    1    2   12     0
 9 0 2    1   23   53     0
 9 0 2   76   12   53     1
 9 0 1    1    2   37     0
99
  0.0      0.0
   15
 $PAR RHO=1.99,E =6.,RAD=1.,NTIMEB=15,ADV1=1.,FRC1=1.,CF=.01,
  ITAVG=10, $END
```

Figure 20. Input data from file DATAW3L for Oregon Inlet, North Carolina, application

SPECIAL PRINTOUT OF CODED FRICTION ARRAY -- CARD GROUP 15

M	N				5					10					15					20					25					30					35					40
1	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	2	2	2
2	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
3	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
4	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
5	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
6	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
7	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
8	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
9	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
10	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
11	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
12	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
13	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
14	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
15	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
16	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
17	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
18	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
19	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
20	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
21	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
22	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
23	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
24	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
25	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
26	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
27	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
28	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
29	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
30	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
31	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
32	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
33	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
34	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
35	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
36	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
37	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
38	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
39	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
40	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
41	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
42	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
43	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
44	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
45	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
46	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
47	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
48	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
49	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
50	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
51	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
52	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
53	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
54	99	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Figure 21. Coded friction array, flags, and a sample of averaged results for Oregon Inlet, North Carolina, application (Sheet 1 of 26)

SPECIAL PRINTOUT OF CODED FRICTION ARRAY -- CARD GROUP 15

M N					45					50					55					60					65					70					75		
1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
5	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
7	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
8	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
9	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
10	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
11	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
12	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
13	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
14	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
15	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
16	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
17	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
18	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
19	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
20	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
21	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
22	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
23	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
24	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
25	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
26	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
27	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
28	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
29	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
30	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
31	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
32	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
33	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
34	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
35	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
36	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
37	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
38	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
39	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
40	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
41	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
42	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
43	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
44	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
45	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
46	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
47	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
48	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
49	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
50	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
51	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
52	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
53	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95
54	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	95

Figure 21. (Sheet 2 of 26)

ICF FLAG ARRAY

M N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	1010	9070	9070	9070	9070	9070	9070	9070	9070	9070	9070	9070	9070	9070	9070	9070	9070	9070	9070	9070
2	7050	6162	6362	6362	6362	6362	6362	6362	6362	6362	6362	6362	6362	6362	6362	6362	6362	6362	6362	6362
3	7090	6163	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363
4	7050	6163	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6263
5	7090	6163	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6263	6262	5062
6	7050	6163	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6162	5060	5050	5050
7	7050	6163	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6361	6150	5050	5050	5050
8	7050	6163	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6361	6150	5050	5050	5050
9	7090	6163	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6263	6363	6263	6361	6150	5050	5050	5050
10	7050	6163	6363	6363	6363	6363	6363	6363	6363	6363	6363	6162	5062	6062	5062	6061	6150	5050	5050	5050
11	7050	6063	6263	6263	6263	6263	6263	6263	6263	6263	6261	6050	5050	5050	5050	5060	6050	5050	5050	5050
12	7050	5062	5062	5062	5062	5062	5062	5062	5062	5062	5060	5050	5050	5050	5050	5050	5050	5050	5050	5050
13	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050
14	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050
15	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050
16	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050
17	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050
18	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050
19	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050
20	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050
21	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050
22	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050
23	7090	6062	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262
24	7050	6163	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363
25	7090	6163	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363
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27	7090	6163	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363
28	7090	6163	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363
29	7050	6163	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363
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53	7050	6062	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262
54	1010	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171

Figure 21. (Sheet 3 of 26)

M N	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
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4	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6360	6050	5050
5	6063	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6263	6263	6363	6363	6363	6363	6363	6360	6050
6	5060	6163	6363	6363	6263	6263	6263	6263	6263	6263	6062	5062	5062	6063	6363	6363	6363	6363	6363	6360
7	5050	6061	6363	6162	5062	5062	5062	5062	5062	5060	5050	5050	5050	5060	6063	6263	6363	6363	6363	6363
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9	5050	5050	5060	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	6161	6363	6363	6363
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15	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	6161	6363	6363	6363	6363	6363
16	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	6161	6363	6363	6363	6363	6363
17	5050	5050	505	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	6060	6363	6363	6363	6363	6363	6363
18	5050	5050	505	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	6161	6363	6363	6363	6363	6363	6363
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21	5050	5050	505	5050	5050	5050	5050	5050	5050	5050	5050	6060	6363	6363	6363	6363	6363	6363	6363	6363
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54	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171

Figure 21. (Sheet 4 of 26)

M N	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
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3	5050	5050	505	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050
4	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050
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9	6363	6363	6363	6360	6050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050
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43	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363
44	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363
45	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363
46	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363
47	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363
48	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363
49	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363
50	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363
51	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363
52	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363
53	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262
54	6171	6171	6171	8171	8171	8171	8171	8171	8171	8171	8171	8171	9171	9171	9171	9171	8171	8171	9171	8171

Figure 21. (Sheet 5 of 26)

M N	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77
1	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050
2	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050
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4	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050
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6	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050
7	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050
8	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050
9	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050
10	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050
11	6260	6050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050
12	6363	6362	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262	6030	1010
13	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6140	1010
14	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6150	1010
15	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6170	1010
16	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6150	1010
17	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6170	1010
18	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6130	1010
19	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6190	1010
20	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6130	1010
21	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6100	1010
22	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6150	1010
23	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6100	1010
24	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6190	1010
25	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6140	1010
26	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6170	1010
27	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6170	1010
28	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6170	1010
29	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6170	1010
30	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6150	1010
31	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6130	1010
32	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6150	1010
33	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6150	1010
34	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6150	1010
35	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6170	1010
36	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6170	1010
37	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6190	1010
38	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6170	1010
39	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6180	1010
40	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6170	1010
41	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6170	1010
42	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6180	1010
43	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6150	1010
44	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6190	1010
45	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6130	1010
46	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6170	1010
47	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6170	1010
48	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6190	1010
49	6363	6363	6363	6363	6363	6363	6363	6363	6363	6343	6363	6363	6363	6363	6363	6150	1010
50	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6150	1010
51	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6140	1010
52	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6140	1010
53	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262	6090	1010
54	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	1010

Figure 21. (Sheet 6 of 26)

SURFACE ELEV AVG
MULTIPLIED BY 100.00

I J	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	[illegible]	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	[illegible]	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	[illegible]	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	[illegible]	0	-1
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	[illegible]	0	-1
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	[illegible]	0	120
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	350	80	70
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	400	400	250
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	450	400	450
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	450	400	450
11	0	0	0	0	0	0	0	0	0	0	0	0	200	0	170	[illegible]	0	500	500	500
12	0	0	0	0	0	0	0	0	0	0	0	0	200	170	200	200	0	500	500	500
13	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
14	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
15	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
16	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
17	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
18	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
19	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
20	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
21	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
22	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
23	149	145	141	140	139	136	138	136	136	138	137	135	136	136	136	137	143	152	154	145
24	111	107	104	103	102	101	101	101	101	101	100	99	99	100	101	102	106	116	117	106
25	87	83	79	75	75	77	77	77	77	77	76	75	75	76	77	79	83	93	94	64
26	64	60	57	56	55	54	54	54	54	54	53	52	52	53	55	56	61	71	73	65
27	45	42	38	37	36	35	35	35	35	35	35	34	33	35	36	37	43	53	57	49
28	32	26	24	23	22	22	22	22	23	22	21	20	20	21	22	23	29	39	44	37
29	23	19	15	15	13	13	13	13	13	13	12	11	11	12	12	13	18	31	34	27
30	17	14	10	9	8	7	7	7	7	7	6	6	5	6	7	7	11	22	27	18
31	13	9	5	5	3	3	3	3	3	2	1	1	1	2	1	1	4	16	19	9
32	9	5	0	-1	-2	-2	-3	-3	-2	-3	-4	-5	-5	-4	-4	-6	-3	2	12	-2
33	1	-3	-7	-8	-9	-10	-11	-11	-10	-11	-11	-12	-13	-12	-12	-14	-12	-1	3	-13
34	-10	-14	-18	-18	-19	-20	-20	-20	-20	-20	-22	-23	-23	-22	-22	-25	-24	-13	-8	-24
35	-22	-26	-30	-30	-31	-32	-32	-32	-32	-32	-33	-35	-35	-34	-34	-31	-37	-24	-18	-35
36	-33	-33	-34	-36	-35	-35	-35	-34	-34	-33	-33	-32	-32	-32	-29	-24	-29	-36	-27	-20
37	-30	-30	-29	-32	-32	-32	-31	-30	-30	-30	-29	-28	-27	-27	-26	-24	-28	-16	-37	-27
38	-27	-26	-26	-28	-27	-28	-27	-27	-27	-26	-25	-25	-25	-24	-22	-16	-15	-42	-32	-16
39	-22	-22	-22	-25	-25	-24	-24	-23	-23	-23	-22	-21	-21	-21	-20	-19	-20	-11	-33	-23
40	-20	-20	-19	-21	-21	-21	-21	-20	-20	-20	-19	-19	-19	-18	-17	-13	-11	-31	-24	-13
41	-16	-16	-16	-17	-19	-19	-18	-17	-17	-17	-17	-16	-15	-15	-15	-14	-13	-5	-27	-21
42	-13	-13	-14	-15	-15	-15	-15	-15	-15	-14	-14	-13	-13	-13	-12	-7	-8	-15	-14	-9
43	-9	-10	-11	-12	-13	-13	-12	-12	-12	-12	-11	-11	-10	-13	-10	-8	-6	-2	-21	-16
44	-7	-8	-8	-9	-10	-10	-10	-9	-9	-9	-9	-9	-6	-7	-7	-6	-6	-1	-4	-10
45	-5	-5	-6	-7	-8	-6	-8	-6	-7	-7	-7	-7	-6	-6	-6	-6	-2	-1	-13	-13
46	-3	-4	-4	-5	-6	-6	-6	-6	-6	-6	-6	-5	-5	-4	-4	-5	-5	-1	2	-12
47	-1	-2	-3	-4	-4	-5	-5	-5	-4	-4	-4	-4	-4	-3	-3	-3	-3	-4	-1	2
48	0	-1	-2	-2	-3	-3	-3	-3	-3	-3	-3	-3	-3	-2	-2	-2	-2	-2	-3	-2
49	0	-1	-1	-2	-2	-3	-3	-3	-3	-3	-2	-2	-2	-2	-2	-2	-2	-2	-2	-3
50	1	0	0	-1	-1	-2	-2	-2	-2	-2	-2	-2	-1	-1	-1	-1	-1	-1	-1	-1
51	0	0	-1	-1	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-1	-2	-2
52	1	0	0	-1	-1	-2	-2	-2	-2	-2	-2	-2	-2	-1	-1	-1	-1	-1	-1	-1
53	0	0	-1	-1	-2	-2	-2	-3	-3	-3	-3	-2	-2	-2	-2	-2	-2	-2	-2	-1
54	0	-1	-1	-2	-2	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-2	-2	-2

Figure 21. (Sheet 7 of 26)

I J	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
1	0	0	-1	-1	-2	-2	-2	-3	-3	-4	-4	-5	-6	-5	-4	0	0	500	500	500
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	300	310	210
3	0	0	0	1	1	2	2	3	3	4	4	5	5	5	3	0	0	6	430	450
4	-1	-1	1	2	2	3	3	5	5	6	6	7	7	7	6	5	6	8	8	500
5	-1	-1	1	2	3	4	5	5	6	7	8	9	8	8	8	6	7	1	10	11
6	-1	-1	0	2	3	5	6	6	7	7	8	7	7	7	8	8	9	11	11	11
7	150	-2	0	1	3	5	6	7	7	8	8	500	500	7	8	9	9	10	11	10
8	300	-3	-2	-1	150	300	600	700	700	600	700	700	500	500	7	8	7	11	10	9
9	500	300	-3	-2	300	500	750	600	500	400	650	720	730	700	700	110	-1	14	9	8
10	350	500	500	500	500	1000	800	700	400	400	750	900	750	800	700	750	10	10	13	14
11	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	5	-5	11	-7
12	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	17	6	13	12
13	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	51	29	13	14	22
14	500	500	500	500	500	500	500	500	500	500	500	500	500	500	79	43	29	24	18	19
15	500	500	500	500	500	500	500	500	500	500	500	500	500	500	68	41	31	25	21	20
16	500	500	500	500	500	500	500	500	500	500	500	500	500	500	64	42	27	27	21	23
17	500	500	500	500	500	500	500	500	500	500	500	500	500	102	63	42	29	30	23	26
18	500	500	500	500	500	500	500	500	500	500	500	500	500	90	63	43	27	13	25	27
19	500	500	500	500	500	500	500	500	500	500	500	500	500	87	64	44	30	15	30	28
20	500	500	500	500	500	500	500	500	500	500	500	500	120	86	62	44	34	24	33	32
21	500	500	500	500	500	500	500	500	500	500	500	129	107	85	63	45	37	23	35	36
22	500	139	147	142	139	137	136	135	136	137	136	114	133	82	62	46	40	20	37	38
23	136	121	111	105	101	99	99	99	102	104	105	105	96	79	62	47	30	22	40	42
24	57	97	89	83	79	77	77	79	84	88	91	94	68	77	61	47	39	29	43	47
25	76	76	69	64	61	60	61	65	69	74	79	83	81	72	59	46	29	31	49	51
26	56	60	55	53	48	46	49	52	57	63	67	71	71	66	56	44	37	32	53	39
27	43	47	43	33	38	39	41	43	46	51	56	60	62	58	52	43	39	41	36	45
28	30	37	34	29	25	30	31	33	37	41	45	49	50	50	46	41	41	41	42	44
29	20	27	25	13	20	23	23	24	27	31	35	38	40	42	40	37	36	46	46	50
30	9	17	15	3	9	14	14	14	19	23	26	29	32	34	35	34	39	49	56	56
31	-2	7	5	-4	-2	5	5	6	10	15	18	20	23	26	29	30	35	57	53	56
32	-16	-4	-5	-16	-13	-4	-4	-2	3	8	11	13	15	18	21	26	37	51	55	55
33	-29	-14	-14	-13	-24	-12	-11	-9	-4	3	5	7	8	10	14	20	47	54	65	53
34	-20	-23	-22	-30	-34	-19	-18	-15	-8	-2	1	1	2	4	7	13	31	50	55	39
35	-23	-33	-30	-15	-15	-25	-24	-21	-14	-6	-3	-3	-4	-3	0	6	24	47	46	39
36	-17	-24	-24	-29	-42	-30	-16	-26	-18	-9	-7	-6	-8	-8	-6	-2	6	18	32	39
37	-19	-42	-36	-11	-13	-36	-27	-17	-15	-13	-10	-11	-12	-13	-11	-7	-6	[illegible]	28	53
38	-12	-17	-22	-26	-34	-24	-13	-27	-23	-16	-14	-14	-16	-16	-15	-13	-14	[illegible]	19	24
39	-14	-34	-33	-7	-10	-36	-39	-15	-11	-21	-18	-18	-18	-19	-20	-18	-17	5	0	11
40	-7	-10	-24	-27	-22	-15	-13	-29	-38	-26	-22	-22	-23	-24	-25	-24	-16	-5	-9	2
41	-11	-23	-24	-1	-9	-30	-32	-9	-8	-32	-30	-33	-30	-29	-22	-27	-32	-14	-7	-5
42	-3	-5	-25	-24	-10	-6	-19	-30	-32	-26	-28	-29	-35	-33	-41	-26	-27	-32	-18	-9
43	-6	-10	-11	-3	-10	-17	-18	-3	-10	-40	-44	-27	-25	-34	-15	-28	-33	-44	-31	-35
44	-4	-3	-19	-19	-1	-5	-22	-23	-16	-7	-23	-15	-19	-22	-37	-11	-15	-23	-41	-38
45	-6	-1	0	-17	-17	-2	-3	-10	-18	-21	-22	-20	-12	-12	-17	-30	-12	-10	-8	-34
46	-12	-7	-1	-1	-16	-16	-8	-4	-2	-2	-18	-19	-19	-9	-10	-14	-29	-16	-6	-5
47	-11	-12	-9	-2	-4	-6	-15	-12	-14	-1	-5	-13	-16	-18	-6	-6	-6	-25	-17	-5
48	-1	-10	-12	-13	1	0	0	-5	-11	-13	-5	0	-7	-13	-14	-9	-2	-2	-7	-4
49	-2	-2	-4	-8	-7	-2	-1	-1	-1	-2	-3	-2	-2	-3	-5	-7	-6	-6	-6	-6
50	-1	-1	-1	-1	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-3	-3
51	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
52	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-2
53	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-2	-2	-2
54	-2	-2	-2	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1

Figure 21. (Sheet 8 of 26)

I J	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
1	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	150	150	80	500
2	200	200	500	500	500	500	500	500	100	500	500	500	500	500	500	150	190	500	500	130
3	210	210	210	[illegible]	100	100	500	100	110	100	100	500	500	500	500	500	200	400	200	500
4	400	300	310	[illegible]	150	150	140	110	120	110	110	150	150	100	500	500	250	200	200	500
5	500	400	410	[illegible]	200	200	150	150	130	200	120	140	160	200	500	150	700	400	200	500
6	10	500	500	450	400	300	200	200	150	300	300	300	200	250	200	200	400	400	300	200
7	9	6	2	500	500	400	300	300	200	320	330	330	320	330	200	200	600	500	400	300
8	7	4	1	[illegible]	500	500	400	300	350	350	350	350	350	350	300	300	400	500	500	600
9	6	1	-1	-2	-2	600	600	500	400	400	400	400	400	400	400	400	400	200	720	1000
10	5	-10	-31	-27	-19	2	7	200	400	400	400	400	400	400	500	400	500	500	300	300
11	-16	-51	-60	-61	-59	-63	-27	31	58	400	400	400	400	400	400	133	137	147	130	120
12	-18	-53	-66	-60	-61	-60	-56	24	12	77	70	66	106	119	125	95	102	102	86	72
13	-2	-13	-62	-61	-61	-63	-42	5	54	83	5	55	74	87	96	111	127	111	91	89
14	13	4	15	-41	-60	-66	-40	-13	59	63	42	45	74	85	98	107	110	[illegible]	79	43
15	16	26	43	6	-74	-52	-29	3	52	48	43	52	69	64	101	93	82	85	41	22
16	22	29	32	19	-53	-43	-13	-20	54	49	57	58	65	85	95	81	79	53	25	6
17	24	28	33	40	-20	-26	5	-5	36	61	57	64	72	85	82	86	64	42	17	[illegible]
18	25	30	35	22	96	-26	-15	-14	-25	66	56	63	60	86	71	75	63	36	1	-15
19	26	31	37	24	51	-18	-8	-5	4	48	57	60	53	60	54	74	47	[illegible]	-6	-21
20	28	32	40	31	27	-10	-6	-2	5	52	62	71	43	28	39	72	40	9	-14	-27
21	35	33	43	34	27	-6	-2	-2	7	-2	67	75	49	25	33	59	33	6	-8	-34
22	45	33	47	40	22	18	-1	-1	5	21	69	76	63	28	40	52	19	[illegible]	-16	-40
23	51	38	52	47	32	45	-1	-1	3	9	58	65	67	59	50	41	0	-16	-6	-25
24	55	43	57	52	40	36	8	2	5	6	49	66	65	63	49	18	-3	-22	-28	-34
25	25	49	63	59	45	63	10	5	6	8	46	54	56	80	47	16	-13	-31	-5	-24
26	35	58	69	66	52	45	5	6	7	6	33	43	55	84	57	7	-20	-36	-38	-28
27	33	55	75	72	58	46	17	11	10	9	19	47	54	58	53	1	-19	-36	-6	-23
28	37	51	81	79	63	45	37	15	13	8	7	39	54	62	46	-12	-32	-23	-39	-23
29	51	44	102	66	68	53	32	18	14	11	2	25	48	59	53	-17	-36	-35	-7	-24
30	53	48	72	93	72	56	55	16	16	10	5	24	41	42	66	-20	-40	-23	-38	-21
31	57	49	79	[illegible]	77	60	48	13	17	11	-2	29	40	41	24	-26	-39	-33	-5	-25
32	60	58	69	119	60	63	72	32	19	11	14	35	40	47	29	-34	-42	-24	-36	-16
33	53	65	74	[illegible]	65	67	69	41	16	13	11	6	35	39	33	-34	-47	-31	-4	-25
34	56	67	70	82	70	68	67	38	20	12	8	11	31	39	-7	-33	-25	-25	-36	-14
35	52	69	73	65	59	68	66	41	19	13	9	5	35	36	-18	-42	-35	-27	-4	-26
36	62	72	70	48	60	66	65	44	18	11	8	-10	19	34	13	-16	-21	-26	-35	-12
37	32	63	62	47	65	67	65	46	17	13	9	15	16	34	9	-36	-36	-25	-3	-25
38	39	42	43	41	49	63	65	41	17	14	10	-17	13	30	13	-11	-20	[illegible]	-33	[illegible]
39	14	22	25	22	64	54	69	82	27	-12	-19	-8	0	7	17	-27	-32	-21	-4	-26
40	1	14	6	[illegible]	28	71	76	72	40	6	-14	-14	-14	0	12	-6	-17	-31	-28	-7
41	-2	-2	-1	15	16	85	97	79	96	30	-12	-10	9	0	13	-22	-25	-15	-7	-25
42	-13	-13	-11	-3	-6	14	57	92	86	38	-6	-11	-5	10	17	-9	-16	-39	-21	-4
43	-42	-36	-20	-22	-21	3	24	44	93	28	12	-4	11	10	-5	-22	-16	[illegible]	-13	[illegible]
44	-11	-26	-42	-12	-16	-27	-12	39	47	52	39	4	4	-6	-16	-19	-14	-22	-9	-5
45	-29	-10	-21	-35	-17	-18	-19	-40	-14	2	-6	-20	-37	-35	-17	-9	-6	-9	-15	-10
46	-27	-23	-15	-15	-24	-16	-16	-14	-59	-64	-39	-17	-13	-15	-23	-23	-8	-4	-5	-16
47	-5	-20	-22	-23	-18	-20	-13	-14	-12	-80	-27	-30	-12	-6	-4	-19	-16	-5	-2	-1
48	-1	-1	-3	-15	-16	-17	-16	-2	-1	2	-5	-13	-15	-16	-8	-7	-14	-15	-10	-5
49	-6	-3	-2	-3	-5	-8	-10	-9	-6	-4	-5	-5	-7	-15	-10	2	2	-2	-3	-3
50	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-2	-2	-2	-2
51	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-1	-1	-1	-1	-1	-1
52	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-1
53	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-1
54	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	0	0	0	0	0	0	[illegible]	0	0

Figure 21. (Sheet 9 of 26)

I J	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77
1	200	500	500	500	500	200	200	200	500	500	500	500	500	500	500	200	200
2	200	500	500	500	500	250	250	250	200	200	200	200	500	500	500	210	500
3	150	500	500	500	500	300	300	300	250	250	250	250	1000	1000	1000	220	520
4	500	500	500	150	400	200	200	200	300	300	300	300	1500	1500	1500	230	500
5	500	120	500	300	300	500	500	500	270	270	270	270	2000	2000	2000	240	350
6	500	140	500	400	250	500	500	500	240	240	240	240	1000	1000	1000	250	320
7	500	200	500	400	200	500	500	500	220	220	220	220	500	500	500	500	300
8	260	300	300	500	300	500	500	500	200	200	200	200	200	200	200	500	200
9	1700	800	600	700	700	400	400	500	200	200	200	200	200	200	200	200	400
10	400	1300	1200	1000	1000	1000	800	400	400	300	300	300	300	300	300	300	440
11	115	112	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
12	67	68	121	130	138	142	145	147	147	148	150	152	153	154	153	150	148
13	62	72	77	86	99	104	109	111	112	113	115	116	117	119	118	115	113
14	41	54	58	66	77	83	88	91	91	93	95	97	97	98	97	94	92
15	19	22	41	50	59	65	71	74	75	77	79	80	81	81	80	76	76
16	3	11	27	34	44	49	56	59	60	61	63	65	66	66	65	63	60
17	-12	5	13	20	28	34	41	43	44	46	48	49	50	50	49	47	45
18	-18	-5	1	6	14	20	25	29	30	31	33	34	35	35	34	32	30
19	-26	-22	-10	-7	1	7	12	15	16	17	19	20	21	21	20	18	16
20	-30	-26	-19	-17	-10	-5	0	2	3	4	6	7	8	7	7	5	3
21	-39	-31	-27	-26	-19	-16	-12	-9	-9	-7	-6	-5	-4	-5	-5	-7	-9
22	-17	-31	-34	-34	-28	-25	-22	-19	-19	-18	-16	-15	-15	-15	-16	-17	-19
23	-35	-39	-22	-25	-36	-34	-30	-28	-28	-27	-26	-25	-24	-25	-25	-27	-29
24	-16	-43	-39	-38	-32	-29	-38	-36	-27	-36	-34	-32	-32	-33	-33	-35	-36
25	-46	-32	-19	-22	-32	-29	-28	-27	-31	-27	-28	-28	-27	-28	-29	-35	-40
26	-14	-40	-48	-33	-27	-25	-28	-27	-22	-26	-25	-25	-25	-24	-28	-31	-35
27	-41	-27	-17	-21	-29	-25	-24	-24	-27	-23	-24	-24	-23	-24	-25	-30	-35
28	-12	-38	-46	-30	-24	-22	-25	-23	-19	-22	-21	-22	-22	-21	-24	-27	-30
29	-40	-23	-15	-19	-26	-22	-21	-21	-23	-19	-21	-20	-20	-21	-22	-26	-31
30	-11	-38	-42	-26	-21	-20	-22	-20	-17	-20	-19	-19	-19	-18	-21	-24	-27
31	-36	-20	-14	-16	-23	-19	-18	-19	-21	-17	-18	-18	-17	-18	-19	-23	-28
32	-10	-36	-39	-23	-19	-18	-20	-18	-15	-18	-16	-17	-17	-16	-19	-22	-24
33	-32	-16	-13	-17	-21	-17	-16	-17	-19	-15	-16	-16	-16	-17	-17	-21	-25
34	-10	-35	-36	-21	-17	-17	-18	-16	-13	-16	-15	-15	-15	-15	-17	-20	-22
35	-30	-13	-12	-16	-20	-16	-15	-16	-17	-13	-15	-15	-14	-15	-16	-20	-24
36	-10	-34	-34	-19	-16	-15	-16	-14	-12	-15	-13	-14	-14	-14	-16	-16	-21
37	-26	-11	-11	-15	-18	-14	-13	-14	-15	-12	-13	-13	-13	-14	-14	-16	-21
38	-10	-33	-31	-16	-14	-14	-14	-13	-11	-13	-11	-12	-12	-12	-14	-16	-18
39	-22	-8	-10	-14	-16	-12	-11	-12	-13	-10	-11	-11	-11	-11	-12	-15	-19
40	-11	-30	-26	-13	-12	-11	-11	-10	-8	-10	-9	-9	-9	-9	-11	-13	-15
41	-16	-5	-9	-12	-12	-9	-8	-9	-9	-7	-8	-7	-6	-8	-9	-12	-15
42	-13	-24	-19	-9	-9	-9	-8	-7	-6	-7	-6	-6	-6	-7	-8	-10	-12
43	-7	-1	-8	-10	-9	-6	-6	-7	-6	-4	-5	-5	-5	-6	-7	[illegible]	-11
44	-13	-13	-10	-6	-7	-6	-5	-4	-4	-5	-3	-4	-4	-5	-6	-7	-9
45	0	-1	-9	-7	-5	-4	-4	-5	-4	-3	-4	-3	-4	-4	-5	-7	-8
46	-15	-5	-4	-5	-5	-4	-3	-3	-3	-3	-2	-3	-3	-4	-5	-5	-6
47	-9	-7	-5	-4	-4	-4	-3	-2	-2	-2	-2	-2	-3	-3	-4	-5	-6
48	-5	-4	-4	-3	-3	-3	-3	-2	-2	-2	-2	-2	-2	-3	-4	-4	-5
49	-3	-3	-3	-2	-2	-2	-1	-1	-1	-1	-1	-1	-2	-2	-3	-3	-4
50	-2	-2	-2	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-2	-2	-3	-4
51	-1	-1	-1	0	0	0	0	0	1	1	1	0	0	0	-1	-1	-1
52	-1	-1	-1	0	0	0	0	0	0	0	0	0	0	-1	-1	-1	-2
53	-1	-1	-1	-1	-1	-1	0	0	0	0	-1	-1	-1	-1	-1	-2	-2
54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	[illegible]

Figure 21. (Sheet 10 of 26)

DISCHARGEY AVG
MULTIPLIED BY 0.10000E-01

I J	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-2
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	-19	-19	-20	-19	-19	-19	-19	-19	-19	-19	-19	-18	-17	-16	-16	-16	-13	-17	-17	-25
24	-25	-25	-25	-25	-25	-25	-25	-25	-25	-25	-25	-25	-24	-22	-22	-23	-23	-20	-19	-22
25	-33	-33	-34	-33	-34	-33	-34	-34	-33	-33	-33	-33	-32	-31	-30	-31	-31	-26	-23	-27
26	-40	-40	-41	-40	-41	-40	-40	-40	-40	-40	-40	-40	-39	-38	-37	-39	-38	-31	-26	-31
27	-42	-42	-43	-42	-42	-42	-42	-41	-41	-41	-41	-41	-41	-40	-41	-42	-41	-33	-27	-33
28	-37	-37	-38	-37	-38	-37	-37	-37	-36	-36	-37	-37	-38	-38	-39	-42	-41	-33	-26	-34
29	-30	-30	-32	-30	-31	-31	-31	-31	-31	-31	-31	-31	-31	-32	-34	-40	-41	-32	-26	-37
30	-26	-26	-27	-26	-27	-27	-27	-27	-27	-27	-27	-27	-28	-29	-31	-35	-43	-34	-25	-41
31	-27	-27	-29	-26	-28	-28	-29	-29	-28	-28	-29	-29	-30	-30	-32	-41	-48	-35	-27	-46
32	-34	-34	-36	-35	-35	-36	-36	-36	-36	-35	-35	-37	-37	-36	-37	-46	-56	-44	-30	-52
33	-45	-45	-47	-45	-46	-46	-46	-46	-45	-45	-44	-46	-46	-45	-45	-56	-63	-47	-31	-46
34	-55	-55	-57	-55	-54	-53	-53	-53	-52	-51	-51	-51	-51	-49	-49	-59	-64	-51	-31	-44
35	-53	-53	-53	-51	-50	-48	-47	-47	-44	-42	-40	-39	-38	-37	-37	-40	-49	-46	-22	-36
36	-37	-37	-35	-34	-33	-31	-29	-28	-27	-24	-22	-20	-19	-19	-23	-25	-23	-36	-26	-23
37	-18	-18	-15	-15	-14	-14	-13	-12	-11	-10	-9	-8	-7	-9	-12	-13	-23	-16	-22	-13
38	-7	-7	-5	-6	-5	-5	-4	-4	-3	-3	-3	-2	-2	-4	-7	-6	3	-7	-20	-5
39	0	0	1	1	1	1	1	1	1	1	1	1	1	0	0	3	-9	15	-7	2
40	2	2	3	2	2	2	2	2	1	1	1	2	0	-3	-2	6	40	-23	-16	19
41	3	3	4	2	2	1	1	2	0	-1	-1	-1	1	1	4	4	-27	51	15	16
42	3	3	4	3	4	4	2	2	1	1	1	1	-3	-7	-1	25	61	-86	-27	36
43	9	9	10	7	5	5	6	5	3	2	2	3	6	7	5	-8	-21	116	13	3
44	13	13	13	13	14	12	10	9	8	7	7	5	-2	-3	15	53	22	-157	7	95
45	25	25	24	20	17	17	18	15	12	11	11	16	19	6	-15	-9	68	121	-137	-93
46	29	29	29	30	28	23	21	21	19	15	11	8	14	28	32	5	-35	1	127	16
47	41	41	37	31	30	29	26	24	24	24	23	19	11	7	17	38	32	-35	-103	21
48	42	42	45	42	38	33	30	27	24	22	24	27	30	26	16	16	41	73	63	-52
49	45	45	45	43	44	41	37	34	31	27	24	23	26	32	37	35	36	56	132	104
50	58	58	56	51	47	45	42	39	37	35	31	28	25	23	26	29	26	22	22	27
51	55	55	57	56	52	49	45	41	38	35	33	31	27	24	21	22	22	2.	15	11
52	57	57	56	56	54	51	46	44	41	37	34	30	26	21	16	10	4	-2	-8	-12
53	54	54	54	54	53	51	49	47	45	42	40	36	33	30	26	22	18	13	10	9
54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 21. (Sheet 11 of 26)

I J	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	-1	-6	-14	-18	-12	-5	-15	-42	-71	-78	-59	-30	-35	-78	-85	-24	0	0	0
4	-1	-1	-2	-15	-26	-28	-19	-9	-22	-45	-68	-83	-82	-53	-43	-47	-46	-15	0	0
5	-1	-1	0	-6	-22	-37	-45	-42	-35	-52	-84	-123	-160	-172	-163	-139	-83	-32	-16	0
6	-3	-4	-4	-4	-13	-26	-43	-60	-71	-81	-107	-136	-179	-211	-215	-214	-179	-95	-52	-23
7	0	-1	-3	-4	-4	-6	-11	-17	-24	-20	0	0	0	-65	-136	-200	-210	-114	-69	-34
8	0	-1	-1	0	0	0	0	0	0	0	0	0	0	0	-45	-120	-189	-115	-80	-46
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-52	-130	-135	-131
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	34	-105	-160	-275
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	16	-20	-23
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	2	2	56
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	9	3	-12	2
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	28	10	-1	5	4
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	11	7	-4	-4	-1
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	15	5	-3	1	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	11	12	10	6	-6	-2	-1
18	0	0	0	0	0	0	0	0	0	0	0	0	0	8	10	10	9	-5	0	-1
19	0	0	0	0	0	0	0	0	0	0	0	0	0	9	11	6	5	-4	-1	-2
20	0	0	0	0	0	0	0	0	0	0	0	0	8	10	8	7	7	-5	-2	-2
21	0	0	0	0	0	0	0	0	0	0	0	0	7	7	8	7	5	-5	-3	-3
22	0	-22	-15	-22	-19	-19	-17	-15	-11	-7	3	2	4	6	6	6	5	-4	-2	-3
23	-19	-20	-22	-23	-24	-23	-21	-18	-14	-11	-8	-2	2	4	5	9	2	-3	-3	-3
24	-26	-21	-26	-26	-27	-26	-24	-21	-16	-13	-10	-4	-1	1	3	5	2	-3	-3	-2
25	-30	-23	-28	-28	-28	-28	-27	-24	-21	-17	-14	-8	-4	-1	1	7	-2	-3	-4	0
26	-32	-23	-28	-28	-28	-28	-28	-27	-25	-21	-18	-12	-8	-5	-2	0	3	0	-4	-5
27	-35	-23	-28	-33	-29	-28	-30	-29	-27	-25	-21	-17	-12	-9	-5	-2	-2	3	-6	-2
28	-39	-24	-29	-34	-31	-31	-32	-31	-29	-27	-25	-21	-17	-14	-10	-6	-4	-3	-4	-7
29	-45	-28	-32	-41	-35	-32	-35	-33	-31	-29	-27	-25	-22	-19	-15	-10	-9	-2	-7	-6
30	-54	-32	-38	-49	-40	-34	-37	-36	-32	-29	-30	-27	-26	-24	-21	-15	-9	-7	-6	-10
31	-62	-36	-42	-56	-45	-35	-40	-37	-32	-29	-30	-30	-30	-30	-28	-21	-13	-7	-10	-12
32	-66	-39	-39	-63	-49	-36	-41	-38	-31	-27	-29	-30	-32	-34	-34	-26	-14	-13	-9	-16
33	-60	-42	-40	-57	-50	-34	-40	-39	-30	-24	-26	-29	-31	-35	-38	-36	-27	-15	-12	-18
34	-43	-41	-26	-37	-43	-33	-37	-36	-29	-22	-23	-27	-30	-34	-38	-36	-31	-11	-17	-23
35	-27	-31	-27	-35	-33	-28	-26	-36	-28	-20	-20	-23	-27	-32	-37	-39	-34	-26	-23	-20
36	-21	-28	-11	-13	-29	-30	-9	-30	-25	-18	-17	-20	-23	-28	-33	-36	-39	-35	-32	-23
37	1	-15	-18	-7	-3	-21	-13	-26	-23	-18	-14	-17	-19	-24	-32	-35	-37	-32	-35	-20
38	-2	-8	8	7	-21	-24	-3	-28	-26	-20	-15	-17	-13	-22	-34	-41	-42	-31	-44	-39
39	22	-11	-29	13	32	4	-50	-37	-31	-27	-19	-23	-21	-22	-42	-59	-53	-36	-54	-43
40	-8	19	62	11	-56	-11	53	19	-52	-31	-24	-39	-32	-21	-42	-91	-71	-57	-57	-56
41	29	-55	-58	67	107	6	-107	-31	39	-18	4	-63	-54	-49	-11	-86	-135	-92	-62	-78
42	13	93	67	-63	-82	54	153	41	-112	-29	18	-2	-53	-2	-101	-65	-101	-172	-102	-93
43	-34	-154	-47	174	86	-127	-122	59	239	102	-10	-24	-17	-133	107	60	-14	-133	-80	-59
44	132	120	-107	-130	91	192	52	-179	-240	-2	46	134	67	38	-200	50	104	137	-148	-166
45	29	54	126	26	-67	-2	164	285	133	-141	-59	-25	70	41	72	-161	-34	-6	73	-54
46	39	22	-32	25	-5	-141	-160	-43	76	87	39	64	68	111	47	145	-3	3	-121	-35
47	85	199	203	63	-76	57	15	39	6	-39	-120	-87	124	143	161	53	149	194	158	-23
48	-3	83	273	210	64	-51	70	152	266	213	1	-36	-21	114	146	39	-106	-52	160	230
49	-50	-121	-69	141	254	159	42	-94	-115	50	227	143	-51	-82	39	197	199	45	30	125
50	4	-67	-190	-173	23	140	127	68	6	-15	25	54	25	-43	-76	-22	56	61	74	90
51	5	-9	-41	-69	-54	-18	7	19	22	18	17	19	16	3	-15	-24	-22	-15	-11	-6
52	-16	-18	-20	-22	-23	-22	-21	-20	-18	-17	-16	-16	-15	-16	-17	-19	-21	-22	-23	-23
53	6	4	3	2	2	1	1	1	1	1	0	1	1	1	1	1	1	1	0	0
54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 21. (Sheet 12 of 26)

I J	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	-3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	13	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	-91	-78	-69	-25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	-349	-441	-421	-365	-243	-86	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	-71	-71	-84	[illegible]	-181	-213	-92	-43	0	0	0	0	0	0	0	-95	-36	-36	-22	-26
12	112	78	9	-20	-73	-62	-122	-46	-144	-14	-71	-33	-37	-24	-2	-3	0	17	23	6
13	16	89	57	-16	-79	-90	-11	-30	35	-124	-32	-33	-20	-23	-21	-3	-11	1	-13	-6
14	-4	30	98	-22	-40	-46	-57	-49	-3	-5	-17	-36	-16	-24	-28	-15	-27	-15	-34	-52
15	-10	4	28	117	58	-12	12	-35	-9	-5	-17	-19	-21	-19	-22	-13	-24	-25	-59	-66
16	-3	1	8	55	56	15	10	-36	-20	-4	-11	-18	-20	-15	-13	-11	-4	-33	-61	-73
17	-4	1	0	29	66	71	13	-1	-43	-2	-14	-18	-20	-14	-19	2	0	-26	-54	-70
18	-3	1	3	-10	49	98	-10	25	-50	-8	-14	-22	-31	-18	-25	-2	1	-21	-53	-62
19	-2	0	0	5	-20	-11	-37	-26	-23	-17	-8	-21	-36	-34	-26	5	3	-20	-50	-56
20	-2	0	1	-1	12	-16	-40	-65	-52	-19	-5	-9	-33	-44	-30	6	13	-8	-44	-52
21	-2	-1	1	2	-5	-12	-27	-42	-12	-36	-2	1	-13	-24	-21	4	6	-2	-37	-32
22	-3	-1	0	1	1	2	-20	-40	-46	-20	-4	4	13	-10	-7	[illegible]	0	6	-21	-27
23	-5	-1	0	1	-2	10	-10	-17	-14	-42	-7	1	10	4	1	16	0	-6	-11	-12
24	-7	-2	0	1	0	4	2	-5	-7	-24	-12	-1	7	2	14	15	4	3	-7	-22
25	-9	-3	0	1	0	31	24	6	-3	-27	-13	-4	-1	8	16	23	6	-16	4	-2
26	-5	-5	0	1	2	-4	7	13	7	-10	-20	-7	-10	-1	16	14	15	[illegible]	-2	-6
27	-7	-8	0	1	1	2	5	15	12	-1	-22	-6	-11	-8	11	4	27	-22	9	8
28	-2	-10	-1	2	2	-2	16	21	17	14	-20	-11	-7	-1	13	5	9	-3	-4	[illegible]
29	-4	-12	-1	2	2	0	7	15	16	21	-11	-13	-10	-6	5	5	1	-17	6	[illegible]
30	-5	-10	-5	2	2	0	9	3	16	21	-9	-3	-10	-9	-1	-3	-12	2	-7	[illegible]
31	-7	-11	-5	2	2	1	7	-1	16	36	-11	1	-4	1	-6	-13	-16	-14	10	[illegible]
32	-11	-6	-9	1	2	0	8	19	25	24	-9	-6	-5	-1	2	-12	-27	4	-7	2
33	-16	-10	-5	-1	2	0	-2	17	16	10	3	-19	-5	-3	-10	6	-26	-14	13	[illegible]
34	-17	-10	-9	-3	2	0	-1	9	13	6	5	-12	-4	8	-10	-10	-9	4	-6	3
35	-23	-13	-6	-6	2	0	0	2	-3	2	6	-23	-5	6	11	-3	-11	-12	14	7
36	-23	-18	-14	-4	2	0	0	-4	-13	-4	34	-18	-13	-5	-1	1	-2	6	-11	4
37	-33	-24	-22	-13	4	0	0	-7	-23	-14	12	0	-14	-8	-8	-4	-15	-11	15	3
38	-27	-36	-35	-13	3	0	4	-8	-35	-45	16	-27	-18	-13	-9	-5	3	6	-23	3
39	-56	-46	-62	-43	[illegible]	-2	0	17	2	-47	-28	-18	-17	-19	-10	-17	-40	-17	45	0
40	-62	-61	-92	-54	-54	-3	1	9	31	63	15	42	1	-11	-20	5	31	[illegible]	-72	15
41	-73	-98	-114	-130	-71	-17	-1	-2	26	30	66	29	45	3	16	-49	-82	-5	84	-45
42	-126	-95	-112	[illegible]	-188	-126	-41	-4	-6	-18	5	51	0	-1	10	13	34	-67	-136	63
43	-269	-182	-72	-249	-267	-212	-152	-60	-2	-77	-39	3	36	24	-88	-158	-116	64	87	-109
44	96	-100	-300	-116	-432	-482	-365	-197	-105	-87	-114	-105	6	64	12	-87	-138	-196	-23	190
45	-180	12	117	-122	-55	-293	-531	-567	-120	-134	-299	-291	-334	-302	-142	-58	-74	-71	-216	-225
46	-65	-145	-71	226	166	161	-63	-45	-100	17	-556	-387	-377	-272	-154	-26	-41	-65	91	[illegible]
47	15	42	61	[illegible]	268	386	442	15	107	7	68	-85	-165	-312	-399	-285	-225	-243	-265	-33
48	109	52	144	[illegible]	212	287	219	104	-534	-412	397	440	580	551	112	-174	46	112	-49	-179
49	137	94	-62	-143	-77	-25	158	282	167	22	-56	-19	101	198	166	28	-17	107	204	135
50	143	186	146	47	-66	-146	-113	22	120	114	59	-19	-209	-258	36	179	33	-65	-39	-5
51	5	23	33	26	2	-29	-51	-51	-38	-29	-33	-45	-77	-116	-93	-25	3	-7	-14	-16
52	-23	-23	-22	-21	-22	-24	-27	-30	-31	-31	-31	-31	-31	-31	-30	-27	-26	-25	-25	-26
53	-1	-1	-2	-3	-3	-4	-5	-6	-6	-7	-8	-9	-10	-10	-11	-11	-11	-12	-13	-13
54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Figure 21. (Sheet 13 of 26)

I J	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	-59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	-20	-59	-32	-24	-19	-17	-15	-14	-14	-14	-14	-13	-13	-13	-13	-13	0
13	-16	-36	-38	-31	-26	-24	-22	-21	-21	-21	-21	-20	-20	-20	-19	-19	0
14	-52	-44	-39	-36	-30	-26	-25	-24	-24	-23	-23	-23	-23	-23	-23	-23	0
15	-67	-57	-44	-41	-35	-33	-29	-28	-28	-27	-27	-27	-27	-27	-27	-27	0
16	-66	-54	-52	-48	-42	-40	-36	-34	-34	-34	-33	-33	-33	-33	-33	-33	0
17	-67	-54	-57	-54	-49	-47	-43	-41	-41	-41	-41	-40	-40	-40	-40	-40	0
18	-70	-58	-60	-60	-55	-54	-50	-49	-49	-48	-48	-47	-48	-48	-48	-48	0
19	-66	-59	-61	-65	-60	-60	-57	-56	-57	-56	-56	-55	-55	-56	-55	-55	0
20	-51	-49	-59	-65	-63	-64	-61	-61	-62	-61	-61	-61	-61	-61	-61	-61	0
21	-31	-39	-49	-60	-61	-65	-62	-63	-65	-64	-64	-63	-64	-64	-64	-64	0
22	-20	-27	-28	-47	-53	-59	-59	-59	-62	-64	-62	-62	-63	-63	-63	-63	0
23	-17	-29	-21	-28	-33	-43	-48	-47	-49	-55	-54	-54	-55	-56	-57	-57	0
24	-4	-14	-11	-15	-16	-17	-23	-30	-27	-31	-32	-33	-33	-35	-38	-38	0
25	-5	-15	-11	-3	-7	-5	-6	-11	-11	-10	-12	-14	-13	-15	-18	-18	0
26	9	-1	-8	-3	-3	-1	-3	-6	-4	-5	-6	-6	-6	-6	-8	-8	0
27	0	-3	-2	1	-2	-1	-2	-2	-3	-2	-3	-3	-3	-3	-2	-2	0
28	12	4	-4	-2	-1	0	-1	-2	0	-1	-1	-1	-1	-1	0	0	0
29	-2	0	2	2	-1	-1	-1	0	-2	0	-1	-1	0	0	1	1	0
30	11	4	-3	-2	0	1	-1	-1	0	-1	0	0	0	1	1	1	0
31	-2	1	3	2	-1	-1	0	0	-1	0	0	0	0	0	2	2	0
32	12	4	-3	-2	0	0	-1	-1	1	-1	0	0	0	1	1	1	0
33	-3	1	3	2	-1	-1	0	0	-1	0	0	0	0	1	2	2	0
34	12	4	-3	-2	0	0	-1	-1	0	-1	0	0	0	1	1	1	0
35	-5	2	3	1	-1	-1	0	0	-2	0	-1	-1	0	0	1	1	0
36	12	2	-4	-2	0	-1	-2	-2	0	-1	-1	-1	-1	0	0	0	0
37	-7	0	2	0	-2	-2	-1	-1	-2	-1	-1	-1	-1	-1	1	1	0
38	14	-1	-7	-4	-1	-1	-2	-2	0	-2	-1	-1	-1	0	1	1	0
39	-30	2	11	2	-5	-2	1	1	-4	0	-1	-1	0	0	2	2	0
40	48	-10	-27	-9	3	0	-6	-3	5	-3	0	0	0	3	2	2	0
41	-73	17	38	7	-6	-2	5	2	-8	3	-1	0	2	1	5	5	0
42	78	-46	-53	-5	10	-1	-10	-1	11	-5	2	1	1	5	2	2	0
43	-65	74	74	9	-11	6	11	-3	-13	7	-3	1	3	0	6	6	0
44	67	-88	-57	10	13	-10	-14	5	10	-12	1	-3	-1	4	-2	-2	0
45	3	114	37	-23	-9	14	1	-21	-15	6	-13	-4	-5	-7	-1	-1	0
46	-196	-156	-21	15	-18	-26	-5	6	-10	-21	-1	-16	-9	-7	-16	-16	0
47	112	2	-58	-20	7	-4	-25	-22	-6	-6	-21	-7	-19	-15	-13	-13	0
48	-98	8	-3	-26	-23	-4	0	-12	-19	-11	-5	-18	-8	-18	-22	-22	0
49	33	8	5	1	-15	-21	-15	-8	-12	-18	-16	-11	-22	-15	-22	-22	0
50	0	-9	-11	-5	-7	-11	-14	-13	-11	-13	-16	-17	-17	-26	-16	-16	0
51	-16	-17	-21	-26	-27	-27	-28	-29	-31	-31	-32	-37	-43	-48	-67	-67	0
52	-27	-29	-31	-32	-33	-34	-35	-36	-37	-39	-42	-45	-49	-52	-53	-53	0
53	-14	-16	-18	-20	-23	-26	-29	-31	-34	-38	-42	-46	-50	-53	-54	-54	0
54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 21. (Sheet 14 of 26)

DISCHARGEX AVG
MULTIPLIED BY 0.10000E-01

I J	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-1	-2
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-1	-2
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-2
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-1
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0
23	0	0	0	-1	0	0	0	0	0	0	0	-1	-1	-1	-1	0	1	-1	0	3
24	0	0	1	-1	0	-1	0	0	-1	0	0	-1	-2	-2	-2	1	1	-4	-2	6
25	0	0	1	-2	0	-1	0	0	-1	-1	0	-1	-3	-4	-2	1	0	[illegible]	-5	[illegible]
26	0	0	2	-3	0	-1	-1	-1	-2	-1	0	0	-4	-5	-3	2	-1	-16	-9	14
27	0	0	3	-4	0	-2	-1	-1	-2	-1	0	0	-4	-6	-3	3	-3	-24	-15	[illegible]
28	0	0	4	-5	1	-2	-1	-1	-4	-1	0	1	-4	-7	-1	7	-5	-33	-22	26
29	0	0	5	-6	1	-2	0	-1	-4	-1	0	1	-3	-6	1	12	-3	-42	-29	40
30	0	0	7	[illegible]	2	-3	0	-1	-4	-2	0	1	-2	-7	4	19	1	-51	-38	56
31	0	0	10	[illegible]	2	-3	0	0	-5	-2	1	2	-2	-7	6	28	7	-61	-50	75
32	0	0	12	-11	3	-3	0	0	-6	-3	2	3	-1	-8	6	39	15	-72	-64	97
33	0	0	14	-12	3	-3	0	0	-7	-3	1	4	-1	-10	6	[illegible]	21	-86	-82	111
34	0	1	15	-15	2	-4	-1	0	-9	-4	1	5	-1	-12	6	60	26	[illegible]	-102	125
35	0	1	14	-17	1	-5	-2	-1	-11	-6	-1	4	-2	-14	6	63	35	-103	-126	[illegible]
36	0	0	12	-16	-2	-8	-4	-2	-13	-9	-4	2	-3	-13	10	64	32	-96	-131	136
37	0	0	9	-16	-3	-9	-5	-3	-13	-10	-5	0	-4	-12	13	65	42	-103	-125	127
38	0	0	7	[illegible]	-4	-9	-5	-4	-14	-10	-5	-1	-5	-10	15	64	33	-95	-111	112
39	0	0	5	-13	-4	-10	-6	-5	-13	-10	-5	-1	-5	-10	15	60	45	[illegible]	-90	103
40	0	0	4	-17	-5	-10	-6	-6	-13	-10	-6	-2	-4	-7	14	50	12	-56	-57	75
41	0	0	2	-16	-5	-10	-7	-7	-12	-10	-6	-2	-5	-8	10	49	42	-134	-63	76
42	0	0	1	-16	-7	-11	-7	-7	-12	-10	-7	-3	-2	-5	4	22	5	15	-124	13
43	0	-1	0	-15	-7	-12	-9	-8	-11	-10	-7	-4	-6	-6	5	33	16	-123	-22	23
44	0	1	1	-14	-7	-9	-6	-6	-10	-8	-6	-2	2	-5	-14	-5	46	57	-186	-65
45	0	2	3	-14	-5	-10	-8	-5	-7	-7	-7	-7	-2	7	7	-11	-31	4	73	[illegible]
46	0	3	2	-11	-5	-7	-8	-6	-6	-5	-4	-5	-8	-7	2	15	9	-33	-53	4
47	0	0	3	[illegible]	-6	-9	-9	-7	-8	-8	-6	-4	-2	-5	-11	-6	14	33	16	-121
48	0	0	-2	-6	-7	-7	-9	-8	-7	-9	-10	-9	-7	-3	-3	-10	-12	1	25	-6
49	0	-2	-5	-10	-12	-9	-10	-9	-8	-9	-10	-11	-13	-12	-10	-10	-15	-21	-18	-12
50	0	0	-3	-5	-9	-10	-10	-10	-10	-9	-9	-10	-11	-13	-13	-13	-13	-15	-18	-17
51	0	0	-5	-6	-9	-10	-10	-10	-10	-10	-10	-11	-11	-11	-12	-13	-13	-13	-12	-10
52	0	2	-3	-5	-8	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-9	-9	-7	-6	-5
53	0	-3	-7	-16	-13	-14	-14	-14	-13	-13	-12	-12	-11	-11	-10	[illegible]	-8	-6	-5	-4
54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 21. (Sheet 15 of 26)

I J	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
1	-3	-4	-8	-30	-40	-27	-14	-21	-52	-77	-69	-64	-51	-86	-145	-126	-15	0	0	0
2	-3	-4	-8	-30	-40	-27	-14	-21	-52	-77	-69	-64	-51	-86	-145	-126	-15	0	0	0
3	-3	-4	-2	-22	-35	-33	-21	-11	-26	-48	-61	-84	-79	-81	-102	-119	-75	-24	0	0
4	-3	-3	-2	-8	-24	-31	-30	-21	-12	-25	-38	-63	-81	-109	-112	-115	-76	-51	-19	0
5	-3	-3	-2	-1	-10	-15	-22	-24	-18	-8	-6	-29	-44	-97	-121	-139	-132	-102	-35	-16
6	0	-2	-2	-1	-1	-2	-5	-7	-7	3	20	0	0	-65	-116	-140	-167	-185	-78	-45
7	0	-1	-1	1	0	0	0	0	0	0	0	0	0	0	-45	-76	-157	-281	-123	-79
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-88	-354	-157	-111
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-36	-276	-152	-115
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-70	-137	-98	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-76	-148	-62	4
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-101	-125	-62	-50
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-25	-85	-115	-47	-64
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-14	-39	-67	-108	-53	-63
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-25	-39	-63	-97	-53	-65
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-37	-42	-52	-89	-57	-64
17	0	0	0	0	0	0	0	0	0	0	0	0	0	-11	-38	-39	-48	-77	-60	-66
18	0	0	0	0	0	0	0	0	0	0	0	0	0	-19	-40	-36	-47	-64	-65	-65
19	0	0	0	0	0	0	0	0	0	0	0	0	0	-29	-41	-36	-43	-55	-67	-64
20	0	0	0	0	0	0	0	0	0	0	0	0	-8	-30	-39	-34	-44	-43	-71	-64
21	0	0	0	0	0	0	0	0	0	0	0	0	-14	-30	-40	-33	-42	-32	-73	-63
22	0	22	-7	7	-2	0	-2	-2	-3	-4	-9	0	-16	-31	-40	-34	-41	-22	-75	-62
23	-1	23	-5	[illegible]	-2	-1	-4	-4	-7	-8	-12	-6	-20	-33	-41	-36	-35	-17	-75	-63
24	3	19	0	[illegible]	-1	-1	-6	-7	-11	-12	-15	-12	-23	-35	-43	-39	-32	-12	-75	-63
25	5	12	5	[illegible]	0	-2	-7	-9	-13	-16	-19	-17	-27	-38	-45	-45	-23	-11	-74	-67
26	7	4	10	[illegible]	-1	-1	-6	-11	-16	-20	-22	-23	-30	-41	-48	-46	-26	-7	-70	-66
27	5	-8	16	11	-2	-1	-4	-12	-17	-22	-25	-27	-35	-45	-52	-49	-26	-12	-61	-71
28	14	-23	21	16	-5	-1	-2	-13	-19	-24	-27	-31	-38	-49	-56	-53	-28	-13	-60	-67
29	22	-41	26	25	-11	-4	1	-14	-21	-26	-28	-34	-41	-51	-59	-56	-29	-15	-54	-67
30	34	-62	32	37	-21	-10	4	-16	-25	-29	-28	-36	-42	-53	-63	-64	-35	-22	-55	-65
31	50	-88	38	54	-33	-19	9	-16	-30	-32	-27	-35	-42	-53	-65	-71	-42	-28	-52	-63
32	64	-115	38	77	-47	-32	14	-21	-37	-36	-25	-34	-40	-51	-64	-76	-56	-30	-56	-55
33	78	-132	36	[illegible]	-53	-48	20	-23	-44	-42	-23	-31	-38	-47	-61	-78	-73	-35	-58	-50
34	77	-134	22	106	-47	-58	24	-22	-53	-50	-21	-27	-34	-44	-57	-77	-80	-46	-60	-44
35	67	-129	18	114	-49	-63	23	-11	-61	-58	-21	-24	-30	-40	-51	-75	-65	-54	-64	-47
36	66	-123	1	116	-33	-62	2	10	-65	-65	-22	-20	-27	-35	-46	-72	-82	-57	-67	-56
37	52	-107	4	116	-37	-44	-6	23	-68	-70	-26	-17	-25	-30	-37	-69	-60	-63	-64	-70
38	50	-101	-11	103	-10	-41	-26	48	-69	-76	-31	-15	-24	-26	-25	-62	-78	-74	-52	-74
39	30	-68	7	66	-29	-12	28	35	-75	-80	-39	-11	-25	-26	-4	-45	-84	-91	-34	-85
40	48	-96	-36	117	39	-57	-36	70	-3	-101	-46	4	-31	-37	17	4	-104	-105	-34	-85
41	38	-11	-32	-8	-2	45	77	-6	-73	-43	-68	72	-40	-43	-20	79	-54	-148	-64	-69
42	60	-90	-26	143	18	-91	-21	107	81	-127	-115	92	12	-94	79	44	-18	-78	-133	-77
43	97	29	-132	-77	106	122	-25	-75	-99	10	-2	106	6	23	-160	91	57	41	-186	-98
44	60	42	95	-54	-114	21	115	156	-38	-227	-50	18	73	52	78	-156	4	[illegible]	100	-80
45	-61	17	25	46	1	-63	-50	36	115	48	-131	-15	-22	82	47	75	-123	-15	22	87
46	-63	35	80	-11	32	74	-29	-82	-2	37	-82	-60	-5	39	112	-21	26	-25	147	1
47	-147	-79	76	130	172	-59	13	-105	32	83	0	-93	-215	20	95	86	-68	-65	153	184
48	-156	-165	-112	[illegible]	318	57	-108	-186	-82	137	213	-56	-229	-115	64	195	77	-122	-27	115
49	-38	-93	-163	-17	205	151	10	-49	-61	-27	36	29	-34	-83	-56	36	76	[illegible]	-7	17
50	-15	-20	-38	-35	10	34	24	11	2	-5	-3	-1	-4	-15	-22	-14	-2	3	1	2
51	-9	-7	-5	-5	-4	-2	-1	-1	0	-1	-1	-2	-1	-2	-3	-4	-3	-3	-3	-2
52	-4	-3	-2	-2	-2	-2	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-2	-1
53	-3	-2	-2	-1	-2	-1	-1	-1	-1	-1	-1	-1	-1	0	0	0	-1	0	0	0
54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 21. (Sheet 16 of 26)

I J	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	-23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	-53	-6	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	-100	-19	10	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	-139	-32	2	-37	-25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	-65	59	-18	-93	-148	-157	-86	0	0	0	0	0	0	0	0	0	0	0	0	0
11	-17	60	-5	-75	-68	-123	-208	-49	-43	0	0	0	0	0	0	95	-59	0	-13	5
12	-74	95	64	-46	-15	-134	-147	-124	54	-131	57	-37	5	-13	-21	96	-61	-16	-19	23
13	-69	24	96	29	46	-123	-226	-106	-11	28	-35	-36	-7	-10	-23	76	-53	-28	-5	18
14	-62	-9	27	149	63	-118	-214	-114	-57	30	-24	-17	-26	-2	-18	65	-41	-46	14	36
15	-73	-23	4	56	122	-49	-238	-68	-83	26	-11	-15	-24	-5	-14	55	-29	-35	48	43
16	-71	-27	-3	13	83	34	-234	-20	-101	10	-5	-7	-23	-9	-15	52	-36	-10	76	52
17	-68	-32	-1	-16	28	50	-176	-6	-59	-31	8	-4	-21	-14	-11	32	-34	12	103	68
18	-66	-35	-4	-4	-37	2	-67	-39	17	-74	14	5	-12	-27	-4	9	-37	41	135	77
19	-66	-37	-4	-5	-8	-8	-41	-46	12	-81	6	17	4	-29	-10	-24	-35	64	165	83
20	-66	-38	-5	-7	-23	20	-17	-23	-1	-115	-8	22	28	-18	-24	-60	-42	84	202	89
21	-67	-39	-6	-10	-14	29	-2	-8	-31	-92	-42	19	43	-7	-26	-85	-45	93	238	84
22	-67	-41	-7	-13	-15	27	20	12	-24	-118	-58	12	34	16	-29	-102	-34	88	265	91
23	-65	-45	-9	-11	-11	16	40	19	-27	-90	-93	4	24	22	-26	-118	-16	94	271	92
24	-59	-50	-11	-12	-10	11	42	26	-24	-74	-105	-6	16	27	-37	-122	-3	95	280	107
25	-51	-55	-14	-13	-9	-20	49	43	-15	-51	-118	-15	13	18	-45	-129	13	118	260	113
26	-50	-56	-19	-14	-9	-14	38	40	-12	-33	-109	-27	16	10	-62	-126	13	141	253	117
27	-41	-55	-26	-15	-9	-15	35	31	-9	-20	-87	-44	21	6	-81	-121	-11	191	223	116
28	-50	-47	-35	-17	-9	-11	17	26	-5	-16	-54	-52	17	1	-94	-113	-15	203	224	114
29	-52	-39	-45	-20	-9	-10	11	18	-6	-21	-22	-50	15	-3	-106	-112	-15	221	200	113
30	-57	-34	-50	-27	-9	-8	3	23	-20	-26	9	-56	22	-5	-113	-111	0	206	208	106
31	-62	-30	-56	-33	-9	-7	-3	32	-36	-46	57	-68	27	-10	-106	-103	3	204	185	106
32	-66	-35	-54	-43	-10	-5	-10	20	-42	-46	90	-71	26	-14	-110	-89	18	173	195	96
33	-68	-41	-59	-46	-13	-3	-9	1	-40	-40	97	-50	14	-16	-103	-105	51	160	169	103
34	-74	-48	-59	-52	-18	0	-7	-9	-44	-32	98	-34	6	-28	-85	-105	50	147	182	92
35	-71	-57	-67	-49	-28	1	-7	-11	-39	-37	94	-5	-11	-39	-89	-91	58	145	157	99
36	-71	-61	-70	-60	-33	3	-6	-8	-29	-47	56	47	-16	-47	-93	-93	60	141	173	85
37	-59	-69	-73	-67	-49	7	-6	0	-13	-56	29	60	-2	-53	-92	-97	72	137	147	97
38	-71	-60	-73	-76	-71	10	-10	11	15	-46	-32	102	-11	-58	-96	-101	64	134	176	72
39	-57	-70	-58	-124	-115	14	-12	-6	30	4	-51	93	-12	-56	-105	-94	88	111	114	117
40	-51	-71	-26	-142	-115	-37	-16	-13	8	-28	-3	66	29	-43	-96	-115	63	142	186	30
41	-55	-46	-11	-126	-173	-91	-31	-12	-20	-91	21	104	13	-1	-109	-54	96	65	98	160
42	-22	-77	7	-45	-177	-153	-116	-48	-17	-79	-1	58	64	0	-119	-57	75	166	138	-10
43	128	-104	-103	133	-159	-208	-175	-140	-74	-4	-38	16	31	12	-7	13	34	-15	115	185
44	-135	94	99	-51	158	-157	-292	-309	-165	-22	-10	7	-79	-44	45	112	86	43	-57	-27
45	-48	-98	-6	139	52	80	-52	-272	-613	-8	155	0	-35	-76	-115	26	103	41	88	-18
46	-17	-17	-79	-147	132	106	173	-290	-557	-124	729	-169	-46	-180	-232	-94	117	65	-66	65
47	-54	-43	-97	-153	-46	6	118	138	-648	-23	669	-14	35	-32	-145	-211	58	83	-44	-166
48	67	15	-189	-190	-75	-65	187	254	-9	-144	-139	-56	-104	-3	296	75	-161	17	118	-35
49	61	59	-32	-109	-140	-117	6	129	106	1	-61	-93	-223	-68	316	214	-116	-106	21	34
50	9	16	8	-9	-27	-35	-27	-4	10	7	-6	-14	-34	-39	24	70	29	-5	-7	-2
51	-2	-1	-1	-1	-2	-3	-4	-4	-3	-1	-1	-1	-1	-1	1	2	1	0	0	0
52	-2	-2	-1	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-1	-1	-1	-1	-1	-1
53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	2	2
54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 21. (Sheet 17 of 26)

I J	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	34	-58	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	61	-19	-26	-7	-5	-2	-3	-2	-1	-1	0	0	1	0	0	0	0
13	70	0	-23	-13	-10	-5	-6	-3	-2	-1	0	0	1	0	0	0	0
14	71	-7	-28	-16	-15	-7	-9	-5	-3	-2	0	0	1	1	0	0	0
15	73	-17	-41	-19	-21	-9	-13	-7	-3	-3	-1	0	2	1	0	0	0
16	69	-29	-43	-22	-26	-12	-17	-9	-4	-4	-2	-1	2	1	0	0	0
17	66	-42	-40	-25	-31	-14	-22	-11	-4	-4	-2	-1	2	2	0	0	0
18	74	-53	-37	-24	-36	-15	-26	-14	-4	-5	-2	-1	3	2	0	0	0
19	84	-60	-35	-21	-41	-16	-29	-15	-4	-6	-3	-2	3	3	0	0	0
20	86	-62	-24	-15	-43	-14	-33	-15	-4	-7	-3	-2	3	3	0	0	0
21	85	-54	-13	-4	-42	-10	-35	-15	-2	-7	-4	-3	4	4	-1	0	0
22	78	-46	-12	14	-36	-4	-36	-15	0	-6	-5	-3	5	4	-1	0	0
23	64	-34	-20	22	-32	6	-31	-16	2	0	-6	-3	5	5	0	0	0
24	67	-24	-23	26	-31	7	-24	-9	-2	3	-5	-3	6	7	3	0	0
25	69	-13	-26	19	-27	5	-24	-5	-2	1	-3	-1	5	9	6	0	0
26	55	-3	-20	14	-27	2	-22	-2	-4	2	-2	-1	6	10	7	0	0
27	62	1	-20	11	-24	1	-22	-2	-2	0	-1	0	5	10	7	0	0
28	51	8	-12	9	-24	-1	-20	-2	-4	1	-2	0	5	9	6	0	0
29	62	6	-13	9	-21	-2	-20	-3	-3	-1	-1	0	5	9	5	0	0
30	52	13	-6	8	-22	-3	-18	-4	-4	0	-2	0	5	8	5	0	0
31	63	10	-7	9	-19	-3	-19	-5	-3	-1	-2	0	5	8	3	0	0
32	53	16	0	7	-21	-4	-17	-5	-5	-1	-2	0	5	7	3	0	0
33	64	14	-1	9	-18	-4	-18	-6	-3	-2	-2	-1	4	7	2	0	0
34	55	22	6	8	-20	-5	-16	-6	-5	-1	-3	-1	4	6	1	0	0
35	67	16	5	10	-17	-5	-17	-6	-3	-3	-2	-1	4	6	0	0	0
36	59	25	11	8	-19	-5	-16	-7	-5	-1	-3	-1	4	6	0	0	0
37	69	19	10	10	-17	-6	-16	-7	-4	-3	-3	-1	4	6	-1	0	0
38	55	34	16	7	-20	-6	-15	-8	-6	-1	-3	-1	4	5	-2	0	0
39	90	2	7	16	-13	-8	-18	-8	-1	-5	-2	-2	3	5	-3	1	0
40	58	60	25	-2	-24	-5	-12	-10	-9	2	-5	-2	3	3	-3	1	0
41	66	-29	5	27	-7	-12	-19	-7	1	-10	-1	-3	1	5	-7	1	0
42	71	95	13	-18	-25	0	-11	-16	-11	6	-8	-2	1	0	-4	1	0
43	28	-43	12	47	-5	-16	-16	-3	-2	-14	2	-6	-1	3	-11	1	0
44	152	113	-19	-20	-8	8	-12	-21	-7	10	-11	-1	-2	-1	-4	3	0
45	-75	3	58	41	-22	-15	1	1	-13	-13	9	-10	-2	0	-10	3	0
46	129	-36	-77	5	11	-7	-20	-10	3	-2	-13	4	-10	-3	-3	3	0
47	-15	75	-16	-33	-14	6	2	-11	-12	0	4	-10	2	-7	-4	5	0
48	-97	-31	-5	-3	-17	-12	0	3	-3	-8	-1	4	-7	3	0	7	0
49	5	-7	-6	0	0	-5	-6	-2	1	-1	-4	-2	2	-7	3	6	0
50	0	-2	-6	-5	-3	-2	-3	-3	-3	-1	-2	-4	-4	-3	-14	1	0
51	-1	-1	0	0	1	2	3	3	3	3	4	4	3	3	7	5	0
52	0	0	1	2	2	3	3	4	3	3	3	3	3	3	3	2	0
53	2	4	5	5	7	8	8	8	8	9	9	8	8	7	7	7	0
54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 21. (Sheet 18 of 26)

VELOCITY V AVG
MULTIPLIED BY 100.00

I J	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-1	-2
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-1	-2	-5
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-2	-4	-10
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-2	-1	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	-375	-375	-378	-379	-377	-376	-376	-378	-376	-372	-369	-363	-351	-335	-326	-335	-356	-353	-338	-356
24	-403	-404	-410	-411	-410	-411	-411	-411	-410	-407	-408	-408	-402	-389	-380	-390	-401	-372	-326	-327
25	-435	-436	-442	-443	-442	-443	-443	-443	-441	-438	-439	-441	-437	-427	-421	-429	-434	-395	-334	-330
26	-436	-437	-443	-443	-442	-443	-442	-442	-439	-435	-434	-437	-438	-431	-429	-434	-441	-394	-325	-318
27	-391	-391	-397	[illegible]	-396	-397	-396	-395	-385	-387	-386	-391	-396	-395	-399	-415	-417	[illegible]	-299	-297
28	-315	-316	-322	-323	-320	-322	-322	-323	-319	-315	-317	-321	-326	-330	-339	-365	-377	-334	-268	-276
29	-242	-242	-249	-250	-248	-250	-250	-253	-254	-252	-251	-252	-256	-261	-275	-311	-342	-311	-245	-267
30	-199	-200	-207	-210	-208	-210	-210	-213	-214	-213	-214	-215	-219	-224	-237	-282	-332	-313	-240	-267
31	-201	-202	-211	-216	-213	-216	-217	-219	-219	-215	-217	-223	-229	-231	-238	-285	-350	-336	-252	-279
32	-248	-248	-257	-261	-258	-262	-263	-266	-265	-259	-258	-266	-274	-273	-273	-318	-366	-367	-268	[illegible]
33	-318	-318	-325	-325	-320	-320	-320	-322	-320	-315	-313	-319	-325	-321	-318	-360	-419	-367	-273	-256
34	-362	-363	-367	-365	-357	-353	-350	-349	-344	-337	-335	-336	-337	-331	-325	-358	-404	-370	-258	-231
35	-324	-324	-324	-318	-308	-300	-292	-286	-276	-265	-251	-242	-237	-231	-227	-235	-269	-282	-198	-167
36	-206	-206	-201	[illegible]	-187	-178	-169	-162	-154	-143	-130	-116	-107	-106	-118	-134	-133	-145	-152	-131
37	-92	-92	-86	-79	-76	-72	-69	-64	-59	-56	-51	-46	-40	-41	-53	-63	-92	-100	-97	-89
38	-30	-30	-26	-23	-21	-19	-18	-16	-14	-14	-13	-10	-8	-11	-21	-26	-7	[illegible]	-55	-51
39	0	0	2	3	2	2	2	3	3	2	2	2	3	2	0	5	-8	[illegible]	11	-8
40	5	5	5	5	5	5	4	3	3	2	2	3	2	-3	-5	5	49	17	-41	-6
41	4	4	5	4	3	2	2	2	1	0	-1	-1	0	2	4	6	-17	18	49	26
42	3	3	4	4	4	4	3	2	1	1	1	1	-1	-5	-4	12	44	-15	-61	5
43	6	6	6	6	4	3	4	4	3	2	1	2	3	4	4	-1	-10	35	48	6
44	6	6	6	6	6	6	5	4	4	4	3	3	1	-1	3	17	19	-35	-38	27
45	8	8	8	7	6	6	6	5	4	4	4	4	6	4	-1	-4	10	33	-3	-42
46	7	7	7	7	7	6	5	5	5	4	3	2	3	5	7	4	-4	-4	16	18
47	7	7	6	6	5	5	5	4	4	4	4	4	3	2	2	5	6	[illegible]	-12	-7
48	5	5	5	5	5	4	4	4	3	3	3	3	4	3	3	2	4	7	9	1
49	4	4	4	4	4	4	4	3	3	3	2	2	2	3	3	3	3	5	8	10
50	4	4	4	4	4	4	3	3	3	3	3	2	2	2	2	2	2	2	2	2
51	4	4	4	4	4	3	3	3	3	2	2	2	2	2	2	1	1	1	1	1
52	3	3	3	3	3	3	3	3	2	2	2	2	2	1	1	1	0	[illegible]	0	-1
53	3	3	3	3	3	3	3	2	2	2	2	2	2	2	1	1	1	1	1	0
54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 21. (Sheet 19 of 26)

I J	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	-2	-5	-11	-16	-22	-30	-31	-46	-81	-110	-120	-114	-96	-62	-107	-168	-177	-76	0	0
4	-8	-12	-12	-18	-30	-37	-50	-56	-66	-90	-100	-98	-100	-99	-96	-102	-113	-102	-42	0
5	-15	-15	-12	-20	-38	-46	-53	-67	-96	-115	-117	-121	-133	-144	-149	-157	-165	-132	-93	-43
6	-9	-16	-18	-25	-37	-54	-64	-69	-84	-106	-120	-134	-152	-160	-155	-154	-157	-134	-104	-83
7	0	-6	-14	-17	-28	-42	-51	-59	-57	-41	-15	0	0	-73	-136	-132	-143	-122	-87	-66
8	0	-5	-9	-4	0	0	0	0	0	0	0	0	0	0	-55	-125	-147	-121	-80	-64
9	0	0	-2	-2	0	0	0	0	0	0	0	0	0	0	0	0	-46	-110	-130	-131
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18	0	0	0	0	0	0	0	0	0	0	0	0	0	87	183	185	165	36	-42	-13
19	0	0	0	0	0	0	0	0	0	0	0	0	0	99	198	174	116	6	-48	-28
20	0	0	0	0	0	0	0	0	0	0	0	0	85	182	171	135	121	17	-57	-35
21	0	0	0	0	0	0	0	0	0	0	0	5	77	136	132	128	106	7	-61	-53
22	0	-231	-381	-360	-351	-360	-338	-301	-254	-182	-44	48	64	56	106	110	101	11	-56	-55
23	-361	-340	-345	-360	-367	-360	-340	-313	-273	-220	-174	-94	0	48	73	113	89	-7	-53	-54
24	-362	-339	-326	-348	-345	-342	-331	-312	-283	-240	-192	-124	-49	2	39	65	53	-7	-51	-48
25	-359	-320	-298	-316	-315	-316	-314	-304	-286	-260	-224	-165	-97	-44	-3	58	37	-37	-57	-34
26	-345	-298	-267	[illegible]	-286	-286	-296	-301	-294	-274	-246	-202	-144	-95	-47	-13	21	20	-39	-82
27	-334	-282	-246	-273	-281	-275	-285	-295	-295	-286	-267	-231	-186	-143	-100	-56	-33	8	-34	-71
28	-334	-286	-240	[illegible]	-293	-277	-289	-300	-294	-285	-275	-253	-222	-190	-152	-111	-78	-53	-57	-98
29	-351	-308	-253	-310	-322	-285	-290	-303	-292	-279	-272	-263	-246	-229	-203	-159	-132	-86	-85	-120
30	-378	-337	-272	-345	-355	-297	-290	-302	-286	-266	-266	-269	-266	-266	-257	-223	-174	-132	-115	-146
31	-405	-361	-285	-366	-362	-301	-286	-297	-274	-248	-247	-261	-275	-291	-302	-282	-232	-163	-140	-184
32	-413	-364	-270	-353	-389	-297	-274	-290	-261	-226	-223	-242	-266	-298	-334	-346	-275	-209	-174	-199
33	-346	-331	-263	-312	-351	-281	-253	-274	-248	-204	-195	-220	-247	-284	-335	-395	-367	-277	-219	-226
34	-265	-252	-202	-195	-250	-239	-227	-253	-236	-185	-168	-191	-223	-259	-308	-367	-406	-355	-263	-268
35	-179	-163	-164	-176	-158	-163	-169	-205	-215	-168	-143	-158	-186	-226	-279	-345	-402	-396	-330	-277
36	-117	-130	-104	-66	-120	-172	-117	-125	-182	-150	-122	-129	-153	-185	-233	-286	-346	-388	-381	-335
37	-31	-37	-86	-65	-27	-67	-96	-119	-158	-137	-108	-106	-123	-149	-203	-255	-302	-328	-369	-326
38	-15	-22	1	32	-32	-102	-64	-82	-146	-129	-100	-92	-103	-119	-172	-236	-289	-290	-323	-371
39	35	16	-62	-25	73	59	-84	-160	-132	-118	-97	-92	-97	-95	-143	-233	-280	-247	-257	-279
40	2	12	90	63	-53	-80	55	95	-50	-123	-84	-99	-114	-86	-102	-227	-295	-252	-227	-227
41	36	-21	-90	8	145	96	-93	-128	10	21	-15	-65	-136	-121	-69	-116	-281	-311	-224	-205
42	26	59	102	13	-86	-15	133	128	-53	-104	-8	13	-46	-46	-87	-141	-146	-254	-270	-202
43	-12	-73	-79	52	107	-15	-110	-27	147	173	49	-19	-23	-86	-15	99	28	-94	-141	-96
44	61	69	3	-67	-11	84	74	-41	-137	-80	16	66	75	40	-63	-57	66	103	-5	-131
45	-12	16	35	29	-12	-18	34	95	91	-3	-46	-20	11	27	38	-24	-52	-11	19	-6
46	7	8	-1	-1	3	-20	-43	-29	5	24	19	19	24	29	26	33	25	6	-22	[illegible]
47	10	27	38	25	-1	-2	7	5	4	-3	-16	-21	4	28	33	23	24	44	46	18
48	-4	5	24	33	19	1	1	16	30	34	15	-3	-4	7	19	14	-5	-11	8	30
49	3	-9	-10	4	20	21	10	-3	-11	-3	14	19	5	-7	-2	13	21	13	4	[illegible]
50	1	-2	-10	-14	-6	7	11	6	3	0	0	3	3	-1	-5	-4	1	6	6	7
51	1	0	-2	-4	-4	-2	0	1	1	1	1	1	1	1	0	-1	-2	-1	-1	-1
52	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 21. (Sheet 20 of 26)

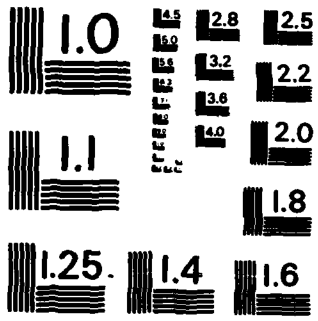
AD-A148 102 EROSION CONTROL OF SCOUR DURING CONSTRUCTION REPORT 7 CURRENT--A WAVE-IND..(U) ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG MS HYDRA.. 2/2

UNCLASSIFIED S R VEMULAKONDA SEP 84 WES/TR/HL-80-3-7 F/G 10/3 NL

END

FILMED

DTIC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1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0

I J	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
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4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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7	-32	4	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	-28	15	27	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	-115	-102	-112	-47	-37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	-307	-456	-584	-556	-468	-366	-148	0	0	0	0	0	0	0	0	0	0	0	0	0
11	-103	-127	-110	-126	-229	-461	-520	-374	-156	0	0	0	0	0	0	-215	-302	-162	-116	-86
12	414	384	134	-11	-107	-180	-444	-523	-617	-492	-434	-557	-330	-258	-108	-16	-7	56	127	88
13	96	481	431	57	-144	-275	-191	-201	90	-379	-784	-323	-298	-255	-238	-116	-74	-57	-55	-94
14	0	196	659	396	-110	-155	-259	-416	-277	-72	-145	-316	-319	-259	-303	-225	-216	-212	-201	-309
15	-78	-20	465	846	545	93	8	-155	-263	-119	-159	-241	-263	-269	-250	-175	-165	-204	-236	-408
16	-23	-3	299	575	514	250	53	-155	-361	-225	-133	-217	-268	-247	-180	-123	-65	-134	-315	-420
17	-40	-11	9	537	868	472	186	36	-332	-347	-154	-282	-301	-260	-217	-104	9	-101	-281	-397
18	-36	-14	131	[illegible]	-65	440	203	47	-221	-382	-226	-303	-409	-367	-268	-148	-3	-70	-248	-369
19	-38	-21	17	159	42	-171	-110	-157	-208	-296	-256	-244	-400	-438	-343	-121	36	-54	-223	-326
20	-41	-26	27	4	57	42	-134	-240	-357	-369	-232	-119	-251	-369	-355	-121	71	21	-161	-285
21	-48	-31	7	114	53	-79	-97	-152	-133	-283	-263	-6	-64	-188	-207	-78	41	17	-117	-204
22	-65	-49	-2	51	44	17	-43	-141	-237	-294	-188	-5	122	33	-84	6	41	16	-44	-137
23	-62	-83	-15	61	15	34	39	-69	-80	-254	-280	-62	89	109	29	62	58	-17	-49	-64
24	-97	-128	-34	48	31	13	28	-5	-31	-138	-213	-116	44	71	72	116	73	21	-10	-75
25	-86	-150	-57	45	58	201	249	77	5	-128	-220	-138	-44	47	120	140	92	-25	-32	6
26	-183	-146	-88	45	96	9	-28	47	42	-23	-168	-184	-155	-105	60	113	85	17	-30	-22
27	-75	-166	-127	36	54	72	43	54	64	26	-129	-175	-145	-148	-8	56	90	21	-34	44
28	-76	-153	-168	27	105	35	47	121	56	89	-52	-185	-151	-72	41	63	37	17	-18	-12
29	-87	-171	-177	12	106	62	40	75	83	108	19	-134	-176	-140	-27	37	16	-40	-24	41
30	-132	-129	-161	-26	107	61	61	67	50	106	25	-60	-99	-150	-77	-14	-39	-27	-12	-16
31	-161	-158	-170	-26	101	76	73	48	34	143	59	-39	-26	-24	-12	-56	-76	-73	-11	43
32	-225	-145	-158	-73	62	60	89	155	128	126	29	-75	-77	-49	-1	-22	-97	-57	-5	-11
33	-261	-213	-127	-62	48	53	-28	51	114	69	35	-82	-133	-59	-60	-24	-47	-93	-3	47
34	-291	-224	-165	-122	19	68	-7	24	70	48	32	-43	-89	19	13	-59	-45	-16	-9	-13
35	-318	-292	-154	-128	-38	56	6	9	3	-2	26	-91	-150	-5	70	28	-31	-45	4	45
36	-333	-326	-231	-113	3	37	5	-25	-64	-52	93	29	-161	-120	-38	-3	-3	6	-11	-15
37	-325	-374	-298	-217	-33	60	7	-43	-128	-122	1	41	-90	-141	-80	-39	-42	-56	10	39
38	-317	-318	-333	-261	-64	32	44	6	-158	-224	-70	-50	-184	-165	-100	-39	-5	17	-29	-34
39	-300	-313	-320	-367	-174	-37	-52	111	119	-90	-151	-102	-104	-132	-100	-51	-61	-77	34	57
40	-245	-258	-323	-335	-364	-266	-28	64	134	188	126	94	75	-28	-65	-29	37	31	-68	-54
41	-222	-249	-314	-344	-437	-381	-175	-30	66	221	210	117	115	82	26	-19	-97	-62	54	26
42	-224	-224	-212	-325	-459	-508	-409	-189	-51	-45	-20	54	49	-2	8	16	25	-16	-85	-21
43	-174	-259	-178	-240	-416	-459	-442	-363	-156	-92	-121	-31	35	54	-30	-115	-105	-15	52	-7
44	-29	-2	-175	[illegible]	-261	-474	-542	-468	-315	-224	-190	-153	-60	37	36	-19	-57	-80	-51	38
45	-72	-43	33	-2	-46	-97	-242	-342	-231	-119	-235	-251	-219	-156	-90	-36	-22	-24	-45	-68
46	-18	-36	-36	25	67	58	16	-18	-24	-14	-90	-157	-122	-97	-60	-26	-10	-13	3	12
47	-1	7	13	26	46	76	93	51	14	13	8	-2	-27	-50	-72	-68	-50	-45	-50	-23
48	26	12	15	25	38	38	35	25	-32	-71	-1	63	75	83	49	-5	-9	12	5	-16
49	15	13	2	-11	-12	-6	7	24	24	10	-2	-4	4	16	19	10	1	5	16	18
50	10	14	14	3	-1	-9	-11	-4	6	10	7	2	-10	-19	-9	9	9	-1	-4	-2
51	0	1	2	2	1	-1	-3	-4	-3	-2	-2	-3	-4	-7	-7	-4	-1	0	-1	-1
52	-1	-1	-1	-1	-1	-1	-1	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-1	-1	-1
53	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-1	-1	-1	-1	-1	-1
54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 21. (Sheet 21 of 26)

I \ J	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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11	-153	-107	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	-42	-268	-357	-27[illegible]	-222	-192	-175	-162	-157	-155	-155	-151	-149	-147	-146	-147	-74
13	-105	-227	-340	-346	-338	-282	-263	-245	-245	-244	-243	-241	-239	-236	-232	-232	-116
14	-372	-376	-356	-343	-320	-295	-278	-259	-255	-253	-249	-247	-245	-246	-246	-246	-123
15	-434	-433	-398	-372	-350	-325	-306	-286	-264	-283	-278	-274	-272	-272	-273	-273	-136
16	-436	-415	-413	-421	-3[illegible]8	-375	-356	-337	-332	-333	-330	-325	-323	-324	-324	-324	-162
17	-441	-426	-431	-45[illegible]	-440	-426	-411	-392	-387	-387	-384	-381	-379	-380	-380	-380	-190
18	-426	-437	-436	-46[illegible]	-462	-453	-445	-43[illegible]	-428	-430	-425	-421	-419	-420	-421	-421	-211
19	-371	-392	-407	-45[illegible]	-460	-457	-455	-446	-448	-450	-447	-443	-442	-443	-444	-444	-222
20	-301	-304	-346	-412	-434	-445	-448	-443	-445	-451	-449	-447	-445	-448	-448	-446	-224
21	-164	-207	-270	-345	-3[illegible]7	-410	-422	-419	-430	-437	-435	-430	-430	-433	-434	-434	-217
22	-133	-136	-163	-224	-301	-344	-367	-371	-382	-398	-400	-396	-397	-401	-403	-404	-202
23	-79	-129	-140	-14[illegible]	-176	-220	-267	-284	-269	-312	-326	-324	-326	-331	-337	-339	-170
24	-68	-46	-66	-7[illegible]	-[illegible]4	-90	-112	-151	-163	-165	-180	-185	-187	-194	-207	-215	-108
25	-18	-52	-68	-33	-28	-33	-30	-45	-68	-58	-60	-70	-72	-76	-69	-97	-48
26	6	19	-24	-2[illegible]	-18	-11	-11	-24	-26	-23	-27	-30	-32	-33	-36	-39	-19
27	21	-6	-12	[illegible]	-2	-7	-6	[illegible]	-12	-13	-11	-14	-14	-13	-13	-12	-6
28	27	39	1	-14	-7	-1	-2	[illegible]	-6	-4	-6	-6	-6	-5	-2	-1	0
29	18	-5	4	[illegible]	2	-4	-3	-1	-3	-4	-2	-3	-2	-1	2	5	3
30	27	36	3	-1[illegible]	-4	0	-1	-5	-2	-1	-2	-1	-1	1	4	6	3
31	16	-3	8	11	2	-3	-2	0	-2	-3	-1	-1	0	1	4	7	4
32	31	37	3	-1[illegible]	-4	1	-1	-5	-1	0	-2	0	0	1	5	6	3
33	12	-4	10	11	2	-3	-1	1	-2	-3	0	-1	1	2	5	7	4
34	32	34	1	-11	-4	1	-2	-4	-1	-1	-2	-1	-1	1	4	5	3
35	6	-6	11	[illegible]	0	-5	-2	-1	-4	-5	-2	-3	-2	-1	2	4	2
36	33	38	-4	-13	-6	-2	-5	-7	-3	-2	-5	-3	-3	-2	1	2	1
37	-9	-15	4	4	-5	-7	-5	-3	-5	-6	-4	-4	-3	-2	0	2	1
38	36	22	-14	-1[illegible]	-7	-2	-5	-7	-3	-2	-4	-2	-2	-1	2	2	1
39	-39	-36	15	13	-3	-8	-2	1	-4	-5	-1	-2	-1	0	2	4	2
40	58	35	-32	-31	-5	2	-5	-7	2	2	-2	1	0	2	4	3	2
41	-68	-38	34	23	0	-6	2	4	-4	-3	2	0	2	2	3	6	3
42	69	17	-44	-27	1	4	-5	-5	4	2	-2	1	1	2	3	2	1
43	-58	2	47	26	-1	-2	5	2	-5	-2	1	-1	1	1	2	4	2
44	58	-5	-33	-11	5	1	-5	-2	3	0	-2	0	-1	1	0	-1	0
45	-34	19	24	2	-5	1	3	-3	-6	-1	-1	-3	-2	-2	-1	0	[illegible]
46	-22	-42	-22	-1	0	-5	-4	0	0	-4	-3	-2	-3	-2	-3	-4	-2
47	8	11	-5	-7	-1	0	-3	-4	-3	-1	-3	-3	-2	-3	-3	-2	-1
48	-20	-6	0	-2	-3	-2	0	-1	-2	-2	-1	-2	-2	-2	-3	-3	-2
49	9	2	1	1	-1	-2	-2	-1	-1	-2	-2	-1	-2	-2	-2	-2	-1
50	0	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-2	-2	-1	-1
51	-1	-1	-1	-2	-2	-2	-2	-2	-2	-2	-2	-2	-3	-3	-4	-5	-2
52	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-3	-3	-3	-3	-3	-2
53	-1	-1	-1	-1	-1	-1	-1	-2	-2	-2	-2	-2	-3	-3	-3	-3	-1
54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 21. (Sheet 22 of 26)

VELOCITY U AVG
MULTIPLIED BY 100.00

I J	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-4	-8
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-3	-6
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-3	-6
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-3	-7
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-2	-4
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	-1	-1	-1	-1	0	1	-1	0	4
24	0	0	0	-1	0	0	0	0	-1	-1	0	-1	-2	-3	-2	1	1	-4	-2	10
25	0	0	1	-1	0	-1	0	0	-1	-1	0	-1	-3	-4	-3	2	1	-9	-5	15
26	0	0	1	-1	0	-1	0	0	-1	-1	0	-1	-4	-5	-3	2	-1	-15	-10	19
27	0	0	1	-2	0	-1	0	-1	-2	-1	0	0	-4	-6	-3	3	-2	-22	-15	24
28	0	0	2	-2	0	-1	0	-1	-2	-1	0	0	-3	-6	-2	5	-4	-28	-21	30
29	0	0	2	-3	0	-1	0	-1	-3	-1	0	1	-3	-5	0	6	-3	-34	-26	40
30	0	0	3	-3	1	-1	0	-1	-3	-1	0	1	-2	-5	2	12	-1	-40	-33	53
31	0	0	4	-4	1	-1	0	0	-3	-1	0	1	-1	-5	4	19	3	-46	-41	69
32	0	0	4	-4	1	-1	0	0	-4	-2	1	2	-1	-6	4	25	8	-52	-50	85
33	0	0	5	-5	1	-1	0	0	-4	-2	1	3	-1	-6	4	31	13	-58	-60	96
34	0	0	5	-5	1	-1	0	0	-5	-2	1	3	-1	-7	4	36	15	-64	-71	102
35	0	0	5	-6	1	-2	-1	0	-5	-3	0	3	-1	-8	4	37	16	-65	-82	107
36	0	0	4	-6	0	-2	-1	-1	-6	-4	-1	2	-1	-7	4	35	19	-60	-87	104
37	0	0	3	-6	-1	-3	-2	-1	-6	-4	-2	1	-2	-6	6	33	19	-55	-81	94
38	0	0	2	-5	-1	-3	-2	-2	-6	-4	-2	0	-2	-5	7	31	18	-51	-70	61
39	0	0	2	-5	-1	-3	-2	-2	-5	-4	-2	0	-2	-4	7	28	17	-52	-56	69
40	0	0	1	-4	-1	-3	-2	-2	-5	-4	-2	-1	-2	-3	6	23	12	-45	-49	55
41	0	0	1	-4	-1	-3	-2	-2	-4	-3	-2	-1	-2	-3	4	19	10	-34	-39	43
42	0	0	0	-3	-1	-2	-2	-2	-4	-3	-2	-1	-1	-2	2	12	9	-24	-41	23
43	0	0	0	-3	-1	-2	-2	-2	-3	-3	-2	-1	-1	-2	1	6	3	-17	-31	6
44	0	0	0	-2	-1	-2	-2	-2	-3	-2	-2	-1	-1	-1	-1	4	[illegible]	-12	-36	-8
45	0	0	0	-2	-1	-2	-1	-1	-2	-2	-2	-1	0	0	-1	-2	3		-21	-32
46	0	0	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	1	0	-3	-3	4	-19
47	0	0	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	1	2	0	-5	-17
48	0	0	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-2	0	4	5	-18
49	0	0	0	-1	-1	-1	-1	-1	-1	-1	-2	-2	-2	-1	-1	-2	-2	-2	1	-2
50	0	0	0	-1	-1	-1	-1	-1	-1	-1	-2	-2	-2	-2	-2	-2	-2	-3	-4	-3
51	0	0	0	-1	-1	-1	-1	-1	-1	-2	-2	-2	-2	-2	-2	-2	-2	-3	-3	-3
52	0	0	0	-1	-1	-1	-1	-1	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
53	0	0	0	-1	-1	-1	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-1	-1	-1	-1
54	0	0	0	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	0

Figure 21. (Sheet 23 of 26)

I J	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
1	-12	-9	-9	-32	-66	-127	-62	-62	-109	-183	-269	-315	-276	-201	-239	-207	-121	[illegible]	0	0
2	-11	-11	-14	-32	-57	-95	-71	-77	-117	-161	-203	-229	-220	-217	-242	-207	-166	[illegible]	0	0
3	-13	-19	-24	-34	-45	-54	-69	-82	-110	-122	-119	-124	-142	-195	-224	-217	-154	-6[illegible]	0	0
4	-17	-25	-25	-37	-41	-42	-58	-57	-72	-85	-86	-91	-102	-134	-173	-186	-181	-13[illegible]	-51	0
5	-17	-21	-16	-29	-34	-34	-36	-36	-40	-41	-40	-53	-62	-94	-120	-129	-141	-142	-88	-30
6	-8	-14	-10	-11	-16	-19	-22	-21	-20	-6	8	-15	-21	-85	-101	-103	-129	-150	-84	-68
7	0	-9	-7	0	-2	-5	-7	-6	-6	3	12	0	0	-47	-101	-85	-121	-191	-101	-84
8	0	-4	-5	1	0	0	0	0	0	0	0	0	0	0	-48	-37	-133	-252	-123	-103
9	0	0	-3	0	0	0	0	0	0	0	0	0	0	0	0	0	-219	-363	-166	-111
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-429	-441	-218	-54
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-512	-464	-229	4
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-430	-442	-221	-75
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-72	-350	-393	-203	-204
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-42	-173	-286	-356	-198	-263
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-110	-193	-350	-318	-219	-269
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-168	-195	-299	-319	-235	-285
17	0	0	0	0	0	0	0	0	0	0	0	0	0	-31	-196	-186	-250	-319	-261	-278
18	0	0	0	0	0	0	0	0	0	0	0	0	0	-83	-197	-177	-223	-285	-277	-297
19	0	0	0	0	0	0	0	0	0	0	0	0	0	-127	-197	-166	-211	-246	-279	-306
20	0	0	0	0	0	0	0	0	0	0	0	0	-21	-151	-190	-154	-203	-192	-285	-302
21	0	0	0	0	0	0	0	0	0	0	0	-1	-57	-148	-183	-146	-159	-135	-296	-305
22	0	38	-12	15	-5	0	-4	-4	-7	-18	-22	-1	-75	-143	-179	-142	-185	-95	-311	-314
23	-1	71	-19	23	-8	-1	-12	-11	-21	-25	-47	-14	-82	-143	-176	-148	-158	-68	-327	-316
24	2	54	-7	[illegible]	-5	-2	-15	-18	-31	-36	-52	-37	-89	-144	-175	-156	-133	-52	-330	-319
25	8	35	6	23	-2	-3	-17	-23	-37	-45	-58	-54	-95	-144	-173	-165	-116	-42	-318	-330
26	11	16	16	20	-1	-3	-15	-26	-48	-51	-63	-66	-99	-144	-173	-172	-95	-33	-302	-333
27	13	-4	24	21	-2	-3	-12	-27	-41	-55	-66	-74	-102	-143	-173	-172	-102	-37	-277	-339
28	17	-25	33	27	-7	-3	-7	-27	-41	-56	-67	-79	-103	-142	-172	-174	-104	-58	-255	-325
29	25	-48	39	33	-16	-5	-1	-28	-43	-57	-66	-80	-102	-139	-171	-176	-106	-67	-244	-310
30	36	-72	45	54	-29	-13	5	-29	-47	-58	-62	-79	-99	-134	-170	-184	-113	-86	-236	-296
31	50	-98	51	74	-47	-25	12	-32	-53	-60	-57	-76	-94	-127	-165	-191	-132	-105	-225	-265
32	63	-124	52	100	-65	-42	19	-35	-61	-64	-51	-70	-86	-117	-155	-195	-169	-122	-226	-227
33	74	-141	48	125	-77	-63	28	-37	-70	-71	-44	-63	-77	-103	-141	-191	-216	-131	-238	-183
34	75	-143	35	135	-73	-88	34	-37	-81	-88	-39	-53	-68	-50	-125	-175	-232	-155	-227	-146
35	65	-134	23	141	-67	-87	35	-26	-92	-91	-36	-45	-59	-78	-108	-165	-217	-165	-205	-135
36	57	-121	11	140	-55	-86	18	-2	-99	-101	-37	-38	-50	-67	-91	-149	-191	-156	-191	-157
37	48	-105	3	123	-44	-70	-3	24	-102	-108	-40	-32	-45	-56	-75	-135	-164	-152	-175	-189
38	39	-90	-3	113	-29	-53	-21	50	-101	-114	-47	-27	-41	-47	-54	-120	-148	-167	-140	-191
39	29	-70	-2	2	-22	-32	0	56	-103	-117	-55	-21	-40	-42	-25	-94	-147	-196	-92	-182
40	26	-63	-12	41	4	-38	-4	66	-54	-130	-64	-5	-45	-50	10	-35	-163	-204	-67	-178
41	27	-39	-28	54	20	-6	20	40	-46	-99	-81	54	-53	-60	-1	63	-129	-225	-92	-153
42	28	-33	-22	50	7	-19	31	52	0	-102	-117	110	-21	-54	38	69	-54	-161	-166	-130
43	42	-20	-53	30	51	9	-22	21	-3	-69	-72	117	11	-50	-41	83	26	-3[illegible]	-232	-133
44	38	19	-16	-47	2	59	33	28	-63	-92	-23	67	38	38	-55	-25	41	3[illegible]	-70	-114
45	1	15	35	-5	-41	-13	28	74	25	-80	-71	3	26	58	58	-46	-55	-5	65	-3
46	-27	11	25	11	9	1	-25	-12	40	29	-75	-25	-10	46	57	24	-47	-21	69	44
47	-39	-6	34	23	52	6	-5	-52	8	34	-26	-45	-62	19	65	18	-10	-33	119	61
48	-53	-43	-6	72	115	-2	-22	-71	-11	55	51	-39	-117	-23	43	75	-1	-54	52	52
49	-35	-43	-51	30	116	45	-23	-55	-33	27	59	-7	-64	-47	3	55	37	-25	-9	35
50	-7	-16	-36	-10	46	39	7	-8	-13	-7	7	6	-9	-22	-17	6	18	7	-1	4
51	-3	-4	-7	-7	1	7	5	2	0	-1	-1	0	-1	-4	-5	-4	-1	[illegible]	0	0
52	-2	-1	-1	-1	-1	-1	0	0	0	0	0	-1	0	-1	-1	-1	-1	-1	-1	-1
53	-1	-1	-1	-1	-1	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 21. (Sheet 24 of 26)

I \ J	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	-31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	-74	-8	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	-100	-22	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	-127	-32	12	-21	-29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	-113	17	-10	[illegible]	-123	-165	-173	0	0	0	0	0	0	0	0	0	0	0	0	0
11	-62	85	-14	-97	-132	-253	-432	-114	-95	0	0	0	0	0	0	135	-69	0	-12	4
12	-126	173	47	-66	-46	-164	-394	-346	19	-241	107	-85	11	-29	-45	265	-191	-20	-31	23
13	-272	171	196	-4	17	-144	-327	-376	88	-165	39	-157	-5	-51	-95	247	-189	-52	-24	33
14	-333	28	268	249	64	-132	-344	-276	-205	165	-125	-101	-74	-28	-90	210	-140	-83	6	35
15	-316	-73	155	[illegible]	132	-92	-289	-206	-382	163	-85	-65	-107	-16	-70	165	-66	-81	42	44
16	-303	-118	3	410	243	-6	-269	-89	-359	103	-42	-46	-96	-31	-60	140	-71	-42	76	47
17	-318	-140	-42	-41	229	49	-232	-21	-255	-75	18	-25	-87	-53	-48	111	-72	6	103	56
18	-330	-159	-45	-216	-149	32	-137	-26	-53	-327	64	2	-62	-65	-24	53	-69	41	129	64
19	-349	-171	-70	-140	-352	-7	-61	-49	25	-423	58	54	-14	-96	-18	-19	-66	68	156	69
20	-374	-189	-82	-164	-312	16	-32	-40	8	-392	-4	107	55	-66	-40	-103	-66	92	186	72
21	-363	-230	-102	-160	-377	69	-11	-17	-19	-316	-138	123	137	-33	-60	-169	-71	106	214	71
22	-320	-285	-118	-177	-304	117	18	2	-32	-255	-263	94	170	15	-71	-206	-59	103	236	70
23	-283	-322	-136	-179	-263	131	58	17	-30	-212	-347	46	142	68	-75	-220	-35	95	243	71
24	-256	-351	-163	[illegible]	-157	114	73	25	-30	-144	-396	-4	100	102	-88	-216	-14	100	240	75
25	-227	-382	-199	-174	-168	-114	89	43	-22	-107	-379	-47	70	106	-117	-214	6	109	229	81
26	-269	-372	-249	-222	-154	-295	118	52	-15	-71	-322	-86	68	71	-161	-211	16	129	214	83
27	-191	-313	-325	-215	-147	-252	135	46	-12	-43	-232	-137	86	37	-220	-193	2	163	194	63
28	-194	-238	-419	-234	-141	-222	111	41	-8	-28	-146	-166	89	16	-285	-172	-15	188	176	[illegible]
29	-225	-175	-404	-260	-136	-178	72	38	-7	-27	-72	-157	78	-6	-380	-160	-14	196	162	76
30	-248	-142	-304	-313	-130	-147	41	47	-16	-32	-12	-152	76	-17	-427	-157	-6	191	153	72
31	-268	-126	-270	-379	-127	-120	-5	79	-35	-47	57	-175	101	-32	-371	-147	1	175	145	69
32	-276	-135	-256	-357	-130	-94	-93	87	-51	-58	124	-183	108	-51	-343	-129	11	161	137	65
33	-266	-167	-244	-264	-154	-58	-146	41	-58	-52	157	-141	77	-62	-323	-131	36	140	129	63
34	-269	-197	-246	-216	-205	-23	-125	-16	-65	-43	156	-89	36	-90	-241	-143	51	126	123	55
35	-269	-231	-252	-172	-227	7	-111	-44	-72	-42	144	-39	-8	-139	-209	-131	53	113	116	57
36	-244	-251	-256	-154	-201	33	-102	-44	-72	-55	108	40	-42	-178	-246	-120	56	115	111	54
37	-194	-242	-233	-171	-217	74	-97	-19	-51	-73	61	97	-26	-203	-271	-124	62	110	108	53
38	-170	-199	-198	-175	-318	133	-126	43	5	-78	-2	141	-16	-204	-287	-129	63	105	106	48
39	-150	-165	-150	-227	-417	193	-168	-1	75	-33	-60	166	-26	-176	-314	-126	68	92	92	51
40	-111	-158	-85	[illegible]	-370	-157	-197	-142	78	-30	-40	133	19	-132	-309	-130	65	93	91	39
41	-101	-116	-35	-291	-334	-480	-213	-179	-105	-174	16	140	44	-55	-304	-98	65	7	92	46
42	-68	-104	-4	-165	-351	-402	-307	-221	-250	-272	17	134	75	-2	-301	-56	66	71	63	36
43	64	-128	-66	60	-284	-371	-397	-362	-300	-138	-50	63	92	13	-147	-22	39	46	62	34
44	11	-19	-20	70	-30	-275	-399	-471	-335	-36	-62	21	-33	-14	16	46	36	6	15	31
45	-94	6	50	51	130	-57	-228	-377	-454	-33	77	7	-80	-57	-20	50	54	15	5	-7
46	-29	-49	-32	40	69	75	39	-236	-505	-51	356	-63	-34	-51	-116	-20	61	22	4	[illegible]
47	-24	-21	-62	[illegible]	34	42	100	-64	-399	-53	481	-67	-6	-71	-117	-87	46	32	-20	-15
48	0	-18	-83	-101	-35	-15	88	112	-200	-46	176	-19	-17	-11	37	-39	-21	22	12	-31
49	33	18	-59	-70	-55	-46	53	101	24	-39	-55	-38	-84	-23	158	68	-58	-15	23	0
50	17	18	-6	[illegible]	-40	-37	-5	31	29	2	-17	-26	-63	-31	85	64	-17	-22	2	4
51	2	3	2	-2	-7	-9	-7	-2	2	1	-2	-4	-8	-9	6	16	6	-1	-1	0
52	-1	-1	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	0	0	0	0	0
53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 21. (Sheet 25 of 26)

I J	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	22	-37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	66	-50	-20	-8	-4	-2	-2	-1	-1	-1	0	0	0	0	0	0	0
13	50	-12	-34	-15	-11	-6	-6	-4	-3	-1	0	0	1	0	0	0	0
14	83	-3	-38	-13	-16	-7	-10	-5	-3	-2	0	0	1	0	0	0	0
15	70	-11	-35	-17	-20	-9	-13	-7	-3	-3	-1	0	2	1	0	0	0
16	62	-19	-38	-17	-23	-11	-16	-8	-4	-3	-1	0	2	1	0	0	0
17	55	-26	-34	-20	-25	-12	-18	-9	-4	-4	-1	-1	2	1	0	0	0
18	54	-35	-29	-17	-27	-12	-19	-10	-4	-4	-1	-1	2	1	0	0	0
19	60	-38	-25	-16	-28	-11	-20	-11	-3	-4	-2	-1	2	1	0	0	0
20	62	-39	-19	-12	-28	-10	-21	-10	-3	-4	-2	-1	2	1	0	0	0
21	60	-37	-12	-8	-27	-8	-22	-10	-2	-4	-2	-1	2	2	0	0	0
22	56	-31	-8	5	-23	-4	-21	-9	-1	-4	-2	-2	2	2	0	0	0
23	54	-24	-9	10	-19	1	-19	-9	0	-2	-3	-2	2	2	0	0	0
24	49	-17	-12	13	-17	3	-15	-7	0	1	-3	-1	3	3	1	0	0
25	43	-10	-13	12	-15	3	-12	-4	-1	1	-2	-1	2	3	2	0	0
26	38	-5	-12	8	-14	2	-11	-2	-1	1	-1	0	2	4	2	0	0
27	35	-1	-10	6	-12	1	-10	-1	-1	0	-1	0	2	4	2	0	0
28	34	2	-8	5	-11	0	-9	-1	-1	0	-1	0	2	3	2	0	0
29	33	4	-6	4	-10	-1	-9	-1	-2	0	-1	0	2	3	2	0	0
30	33	5	-4	4	-10	-1	-8	-1	-1	0	-1	0	2	3	1	0	0
31	32	6	-3	4	-9	-1	-6	-2	-2	0	-1	0	2	3	1	0	0
32	32	7	-1	3	-8	-1	-7	-2	-2	0	-1	0	2	2	1	0	0
33	31	8	0	3	-8	-2	-7	-2	-2	0	-1	0	1	2	1	0	0
34	32	8	1	3	-7	-2	-7	-2	-2	-1	-1	0	1	2	0	0	0
35	32	9	2	3	-7	-2	-6	-2	-2	-1	-1	0	1	2	0	0	0
36	32	9	3	3	-7	-2	-6	-2	-2	-1	-1	0	1	2	0	0	0
37	32	10	4	3	-7	-2	-6	-2	-2	-1	-1	0	1	2	0	0	0
38	32	11	5	3	-7	-2	-5	-3	-2	-1	-1	0	1	1	0	0	0
39	36	8	4	4	-6	-2	-5	-2	-1	-1	-1	0	1	1	-1	0	0
40	34	12	5	2	-6	-2	-5	-3	-2	-1	-1	0	1	1	-1	0	0
41	31	6	5	4	-5	-2	-5	-3	-1	-1	-1	-1	1	1	-1	0	0
42	32	11	3	2	-5	-2	-4	-3	-1	-1	-1	-1	0	1	-1	0	0
43	19	10	4	4	-4	-2	-3	-3	-2	-1	-1	-1	0	0	-1	0	0
44	27	8	-1	4	-2	-1	-3	-3	-1	-1	-1	-1	0	0	-1	0	0
45	12	15	5	2	-3	-1	-1	-2	-2	0	0	-1	0	0	-1	0	0
46	8	-4	-2	3	-1	-2	-2	-1	-1	-2	0	-1	-1	0	-1	0	0
47	16	4	-10	-3	0	0	-2	-2	-1	0	-1	0	-1	-1	-1	0	0
48	-14	5	-2	-4	-3	0	0	-1	-1	-1	0	-1	0	0	0	1	0
49	-11	-4	-1	-1	-2	-2	-1	0	0	-1	0	0	0	0	0	1	0
50	1	-1	-1	0	0	-1	-1	0	0	0	0	0	0	-1	-1	1	0
51	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52	0	0	0	0	0	0	0	1	1	1	1	0	0	0	1	0	0
53	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
54	0	0	0	0	1	1	1	1	1	1	1	1	1	0	0	0	0

TIMES FOR START,STOP, AND EXECUTION -- 6.366 22.893 16.527

Figure 21. (Sheet 26 of 26)

PART VIII: SUMMARY AND CONCLUSIONS

67. This report describes the development of a generalized numerical model for coastal currents induced by breaking waves. The model employs the radiation stress approach of Longuet-Higgins and solves the vertically integrated equations of momentum and continuity using an alternating direction implicit scheme. It includes mixing and advection terms.

68. The model has the following desired features in terms of application to engineering projects: the ability to handle real-life bathymetries, flexibility in terms of formulation of mixing and friction terms, computational efficiency, and economy.

69. The model was applied to a case of normally incident waves on a plane beach. The results for setup matched the experimental data of Bowen, Inman, and Simmons (1968).

70. For oblique incidence of waves on a plane beach, model results for longshore currents were compared with the analytical solution of Longuet-Higgins, first neglecting the effect of setup and later including the effect of setup. Agreement was excellent. As the numerical grid was made finer, the numerical results tended to converge toward the analytical solution. Next, the effect of lateral mixing on the velocity distribution was studied. As the mixing parameter P increased, the numerical solution exhibited the proper behavior, since the magnitude of the peak decreased, the peak moved closer to the shoreline, and the velocities offshore of the breaker line increased.

71. The model was finally applied to a field situation corresponding to Oregon Inlet, North Carolina. The bathymetry was very irregular and complex owing to the presence of channels and shoals. A variable grid was used. The significant wave condition during a part of the Ash Wednesday storm of March 1962 was selected for simulation. The numerical results obtained for this case appeared to be reasonable and the computer costs were modest.

72. For the convenience of the potential user, model input, output, and files are described and two sample applications are presented.

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APPENDIX A: NOTATION

a_1	Mapping function, dimensionless
a_{m+1}	Coefficients, 1/sec
$a_{m+1/2}$, $\underline{a}_{m-1/2}$	Coefficients, sec
$a_{m+1/2}$	Coefficient, dimensionless
A_m	Computational parameter, ft
b_1	Mapping function, dimensionless
$B_{m+1/2}$	Computational parameter, ft/sec
c	Drag coefficient (of the order of 0.01), dimensionless
c_1	Mapping function, dimensionless
C	Phase speed, ft/sec
d	Total water depth including setup, ft
d_b	Water depth at wave breaking, ft
E	Wave energy density, lb/ft
g	Acceleration due to gravity, 32.174 ft/sec^2
h	Bed elevation with still-water level taken as zero, ft
$\|h\|$	Local still-water depth, ft
H	Local wave height, ft
H_b	Breaking wave height, ft
H_o	Deepwater wave height, ft
k	Local wave number, $2\pi/L$, 1/ft
L	Local wavelength, ft
L_b	Breaking wavelength, ft
m	x-index of arbitrary cell center
n	y-index of arbitrary cell center
n	Ratio of wave group celerity to wave phase celerity, dimensionless
N_{LH}	Empirical coefficient that varies from 0.000 to 0.016, dimensionless
P	Mixing parameter which varies between 0 and 0.40, dimensionless
P_m	Recursion coefficient, sec
P_M	Recursion coefficient, sec
Q_m	Recursion coefficient, ft
Q_M	Recursion coefficient, ft

R_m	Recursion coefficient, 1/sec
R_M	Recursion coefficient, 1/sec
s	Beach slope, dimensionless
S_m	Recursion coefficient, ft/sec
S_M	Recursion coefficient, ft/sec
S_{xx}	Radiation stress in the x-direction (normal to the y-z plane), lb/ft
S_{xy}	Radiation stress in the y-direction in the x-z plane, lb/ft
S_{yy}	Radiation stress in the y-direction (normal to the x-z plane), lb/ft
t	Time, sec
T	Wave period, sec
T1	Computational parameter, dimensionless
T2	Computational parameter, dimensionless
U	Depth-averaged horizontal velocity in x-direction, ft/sec
$<\lvert U_{orb}\rvert>$	Time-averaged wave orbital velocity at the bottom, ft/sec
V	Depth-averaged horizontal velocity in y-direction, ft/sec
x	Horizontal Cartesian coordinate, ft
y	Horizontal Cartesian coordinate, ft
z	Vertical Cartesian coordinate, ft
Z	Arbitrary variable
α_1	Computational space coordinate, ft
α_2	Computational space coordinate, ft
γ	Wave breaking index on the order of 1.0, dimensionesss
δ_{α_i}	Difference operator
Δt	Time increment, sec
Δx	Cell dimension in x-direction in real space, ft
Δy	Cell dimension in y-direction in real space, ft
$\Delta\alpha_1$	Cell dimension in α_1-direction in computational space, ft
$\Delta\alpha_2$	Cell dimension in α_2-direction in computational space, ft
ε_x	Eddy viscosity in the x-direction, ft^2/sec
ε_y	Eddy viscosity in the x-direction, ft^2/sec
η^*	Water-surface elevation at intermediate time level, ft
$\bar{\eta}$	Displacement of the mean free surface with respect to still-water level, ft
θ	Local wave direction, deg

μ_1	Expansion coefficient, dimensionless
μ_2	Expansion coefficient, dimensionless
π	3.14159, dimensionless
ρ	Mass density of seawater, 1.99 $lb\text{-}sec^2/ft^4$
τ_{bx}	Bottom friction stress in the x-direction, lb/ft^2
τ_{by}	Bottom friction stress in the y-direction, lb/ft^2
τ_{xy}	Lateral shear stress due to turbulent mixing, lb/ft^2

Symbol

∂	Partial derivative symbol, dimensionless

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